is the balcony framing. Each frame consists of a pair of horizontal 6-in. channels and above it a pair of inclined channels, the former having a cantilever projection of about 11 ft. from the face of the truss. The frame is riveted to a connection plate on the inner chord.

The designers state that a point of particular importance is the low weight and cost of the steel frame, without sacrifice in strength. This was made possible after thorough investigation of economical spacing of trusses and the design of structures of this kind.

The drill-hall roof was designed for a dead load of 30 lb. per sq.ft. of actual roof area, and a dead load of 80 lb. per sq.ft. for the cantilever balcony. In addition, provision was made for a snow load of 25 lb. per sq.ft. (horizontal projection) of roof area, and a live load of 100 lb. per sq.ft. for the balcony. The wind load was taken according to the Chicago city ordinance, namely, 20 lb. per sq.ft. of vertical projection, acting horizontally. For the stress diagrams each one of the loadings for the trusses was plotted separately and tabulated, in order better to determine the reversals and maximum simultaneous stresses for which to design the stress members.

The weight of steel frame on the basis of the projected area is shown in the accompanying table. It is thought to compare very favorably with ordinary roofs subjected to similar loading and under conditions which are considered much more economical.

WEIGHT OF STEEL IN ROOF OF DRILL HALL

	Weight, Lb.	Area, Sq.Ft.	Lb. per Sq.Ft.
Truss, each	62,600	7,366	8.5
Purlin, each	2,050	607	3.4
Rafter		5.33	1.8
	(Av. 9.75 lin.ft.)		

The allowable unit stresses used comply with the Chicago city ordinances, which allow a tensile stress of 16,000 lb. per sq.in. of net area and a compressive stress of 16,000 — 70 $L \div r$ per sq.in. of gross area, allowing an increase of 50% for combined dead, live and wind stresses. Rather than compute the resisting strength of members for both conditions of strain, the engineers prepared in their tabulation of member stresses, a column designated "equivalent" stresses, being 66.7% of the total combined dead, live and wind loads. Thus they were enabled to see at once the condition of maximum loading for which to design the different members.

An unusual feature is the absence of any strut at or near the center hinge, thus allowing a clear passage for the light rays from the 36-ft. skylight in the center. This construction necessitated the design of a special pin connection capable of resisting the side-buckling tendency due to horizontal thrust.

Upon investigation after the erection of the trusses, it was found that the purlins (designed for wind stresses on the ends of the drill hall, as well as the dead and snow loads) were capable of sustaining the dead load of one truss. This fact allowed the removal of the eye-bars of the ties between the lower pins, which was a practical necessity when it was decided to excavate for a basement. The bars of one of the trusses were slightly heated, and it became an easy matter to remove the pins connecting the various section of bars and so allow the excavator to work freely and to advantage.

The erection was done by a steel traveler on the ground level. It had a tower 38 ft. square and 38 ft. high. On the elevated platform were two 40-ft. steel masts with

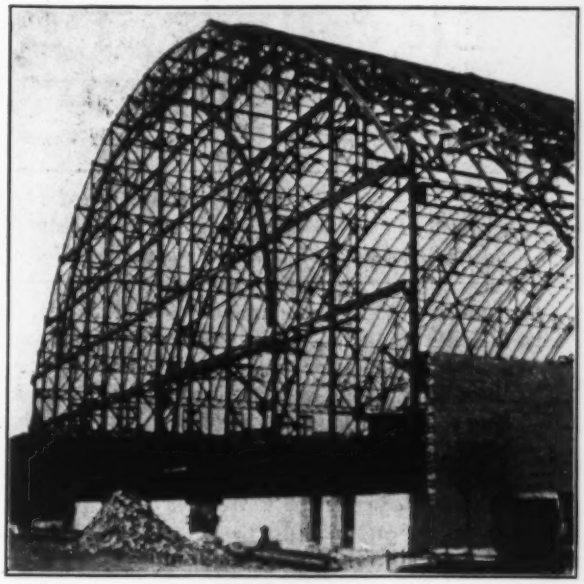

FIG. 2. COMPLETED FRAMING OF THE DRILL HALL

90-ft. booms. Each half-arch was assembled on the floor and then raised into a vertical plane, with its heel end resting in the shoe (and its head on the floor); it was then swung up, revolving on the shoe pin. The two half-arches were raised almost at the same time by the two booms, and the completed truss was then held by guys while the traveler set the purlins.

The steel in the drill hall has a total weight of about 950 tons. It was erected in about 150 days. The length of time was due in part to the fact that when the erection was nearly completed for the building as originally planned, the state legislature made an appropriation for an extension to the drill-hall portion. This addition required the fabrication and erection of material for two bays (about 74 ft.).

The armory was designed by James B. Dibelka, State Architect. The structural design of the drill hall was prepared by the Westcott Engineering Co. The general contractor was C. E. Carson. The steelwork was built and erected by the Morava Construction Co. All these firms are of Chicago.

A Small Bobtail Draw—In building a swingbridge across a neck of Lake Lucerne at Stansstad, Switzerland, for 22 m. clear opening, the engineers for the Canton Nidwalden adopted the bobtail swing type but detailed it in such manner as to make substantially a single-leaf swing. The short arm ends just beyond the turntable, so far as the bridge floor is concerned. It extends out under the approach floor, however, as counterweight for the long arm. The approach deck over this counterweight has supports at one side only, the other side being left clear to allow the counterweight to swing out. The result of this arrangement is that rocking action due to live-load on the short arm is nearly eliminated, making it possible to dispense with wedging or tight latching at the outer end of the long arm, as well as with bearings under the short arm. The operating machinery is thereby simplified, and the required power reduced, which (the bridge being hand-operated) means that the time required for opening and closing is reduced. The end of the long arm has one lower and two upper track-wheel supports, and these enter between tracks inclined slightly upward, as the bridge closes. There are also two flat bearings, one under each girder, but they are adjusted to be barely in contact when no live-load or wind is acting. The turntable is center-bearing and has two side wheels and two at the quarter-points nearest the channel. Prof. A. Rohn, of Zürich, designer of the bridge, described it fully in the "Schweizerische Bauzeitung" of Dec. 4 and 11, 1915.

Elevation of Low-Level Streets on Pittsburgh River Front

By Charles M. Reppert*

SYNOPSIS—Grade elevation just completed at Pittsburgh, Penn., to raise low-level streets above flood level. Details of drainage system installed.

Continuing a policy inaugurated a few years ago, the City of Pittsburgh during the present season awarded an additional contract for the raising of low-level streets above flood level. This latest contract, which is now approaching completion, includes a section of the downtown business district extending from the Point along the Allegheny River frontage to Anderson St. It is the intention here to describe the work briefly with particular reference to the costs and drainage system.

The territory involved includes Penn Ave., one of the main business streets of the city, to Eleventh St., a distance of about 0.9 mi., and Duquesne Way on the Allegheny River front from Barbeau St. near the Point to Anderson Street, 0.5 mi. The grades of these streets, together with those of intersecting streets and alleys, have been raised to elevations ranging from 33.9 to 33.3 ft., city datum, which brings the street surfaces above all but the most extreme floods. The maximum flood on record, that of March 15, 1907, was 36.6 city datum. The maximum grade change on Penn Ave. is 3.5 ft., near Water St., but for the greater part of the length affected the changes in grade are 2 ft. or less. On Duquesne Way and the intersecting streets the grade changes in general are considerably greater, the maximum on Duquesne Way being 8.4 ft. at Barker's Way. The street for a considerable distance is raised from 5 to 7 ft.

The total length of streets affected by the grade change is 1.6 mi.; with 0.7 mi. of alleys 20 ft. or less in width the total is 2.3 mi.

This improvement was undertaken largely at the request of property owners. As has been the case in similar sections, before proceeding with the work the city secured waivers of damages from a large percentage of the property owners affected. In all, about 75% of the property owners waived damages. It is estimated that the total net damages falling upon the city will not exceed $60,000.

A contract was awarded April 23, 1915, for the execution of the physical work at unit prices, the total amount of the contract being $152,484. This contract included the removal of existing pavements, the placing of filling, new curb, pavements and sidewalks, and the installation of the necessary drainage system. In addition to the work involved on the streets affected by the change in grade, the repaving of Penn Ave. from Sandusky St. to Eleventh St. was included. The principal unit costs and quantities were as follows:

Class of Work	Quantity	Unit Price	Amount
Embankment	33,000 cu.yd.	$0.35	$11,550
Standard sheeet-asphalt repaving	6,300 sq.yd.	2.00	12,600
Repaving with block stone, Type 1	9,800 sq.yd.	3.00	29,400
Repaving with creosoted wood block	8,200 sq.yd.	2.85	23,370
Repaving with creosoted wood block, not including foundation	4,000 sq.yd.	2.35	9,400
Protected concrete curb	20,000 lin.ft.	.75	15,000
Concrete sidewalk	150,000 sq.ft.	.12	18,000

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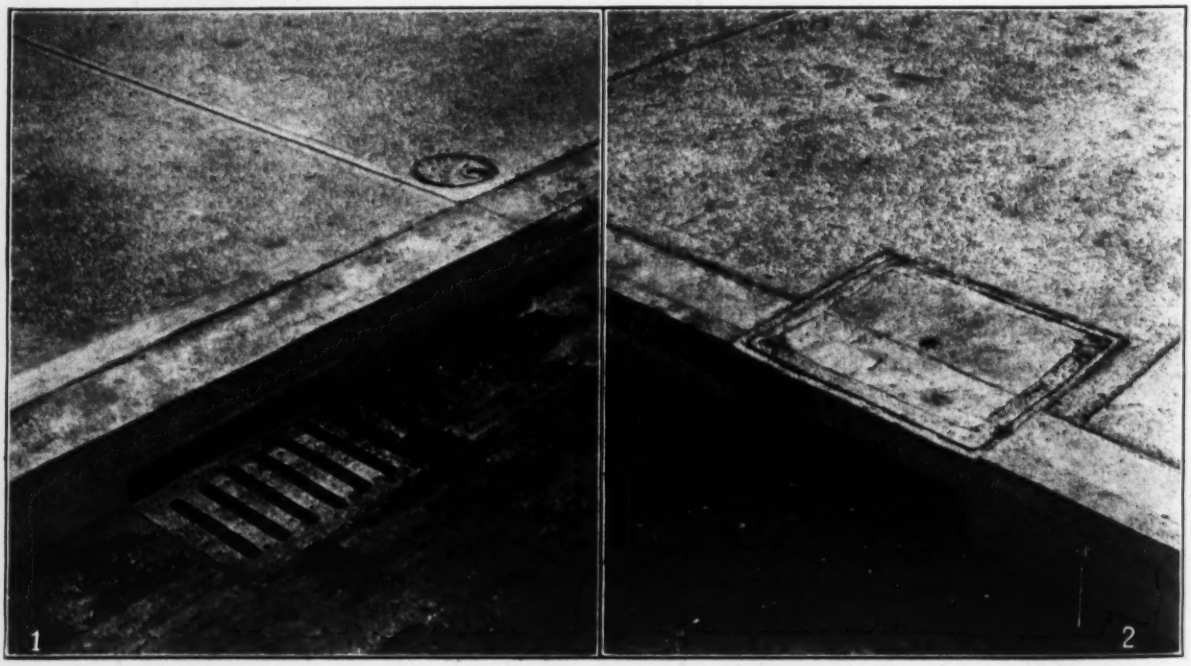

FIGS. 1 AND 2. CURB INLETS USED ON FLAT-GRADE STREETS OF PENN AVE. FLOOD FILL, PITTSBURGH

Fig. 1—Inlet type 1. Fig. 2—Inlet type 5

The cost of the drainage system will be stated later. A classified statement of the cost of the work as contemplated in the original contract is as follows:

New pavement, 29,250 sq.yd.	$78,690.00
Curbing, 23,600 lin.ft.	16,887.50
Granite crossings, 2,000 sq.ft.	1,460.00
Concrete sidewalks, etc., 150,350 sq.ft.	18,075.00
Sewerage and drainage (original contract)	25,061.50
Grading, 33,000 cu.yd.	11,550.00
Miscellaneous	760.00
Total	$152,484.00

physical work to $211,484. With the addition of the estimated damages, the total cost to the city will be, as far as can be now determined, $271,484, exclusive of engineering and inspection.

The expenses incurred by property owners in changing their buildings to conform to the new grade and those incurred by public-service corporations in adjusting their surface and subsurface structures cannot be estimated at

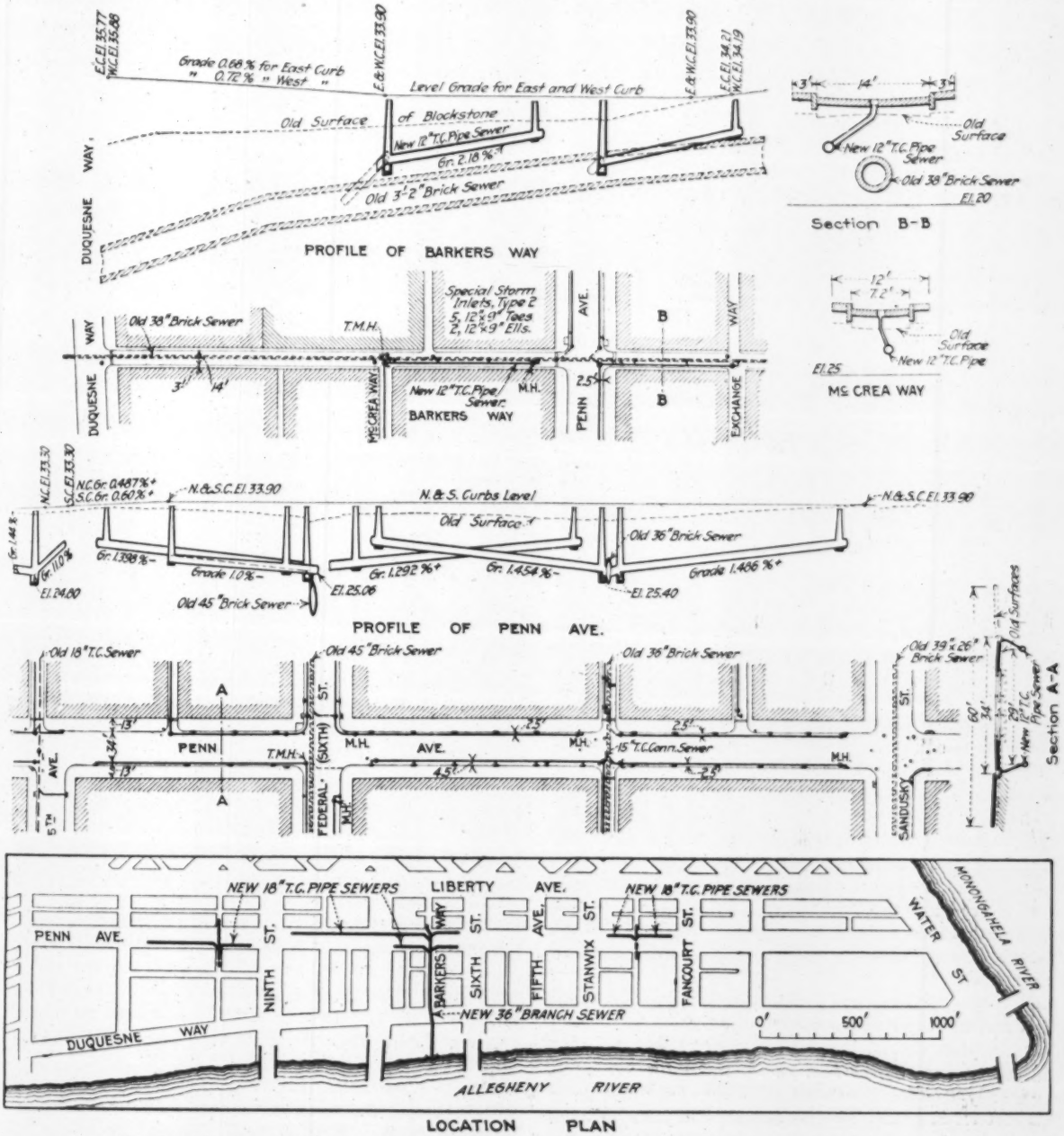

FIG. 3. TYPICAL PORTIONS OF PENN AVE. FLOOD FILL, SHOWING DRAIN ARRANGEMENT

Other items of cost not included in the foregoing are as follows: Raising and relaying water lines, done by city force, $20,500; a supplementary contract for a sewer on Barker's Way, $21,000; additions to original contract on account of changes in type of pavements and additional work, $17,500. This brings the total cost of the

the present time. The street-railway company has necessarily been compelled to raise its tracks on all streets where the grades were changed.

With regard to expenses incurred by public-service corporations, the change in grade has not been sufficient to affect their subsurface structures to any great extent,

except on Duquesne Way, where it has been necessary to relay the gas lines and electrical conduits. The expense incurred by private property owners is very difficult to estimate. In all but a few instances sufficient headroom has been available, and alterations have been made by raising the floors to the new sidewalk level. In a few cases the entire building has been underpinned and raised to grade. The larger and more valuable buildings built in the district during recent years have conformed to the new grades.

New Street-Drainage System

From a strictly engineering standpoint the most interesting feature of this improvement is in the system of drainage carried out. The district includes part of the oldest business section of the city, and as noted on the accompanying plan, the sewer system is rather peculiar in that the sewers are laid for the greater part only on the streets normal to the Allegheny River. This has been possible since the blocks are short. Private drains, the location, size and condition of which are unknown, have been utilized in many cases.

The new grades were necessarily established to conform to existing conditions and were further restricted by the requirements as to grade contained in the waivers secured from property owners. Owing to conditions, it became necessary to establish level grades for a considerable distance on Penn Ave. and other streets and alleys. The absence of lateral sewers, combined with the level grade, made it impossible to adopt the usual practice of constructing the ordinary catchbasins at street intersections and at intermediate points where necessary.

A complete resewering of the district was not possible on account of the cost and the delay which would necessarily ensue. Furthermore, while the drainage of this district has received considerable study, an ultimate plan has not been determined upon, nor were funds available for the construction of such a system, for the immediate execution of which there is no pressing need.

The streets affected carry very heavy traffic and are much used for retail business. Hence it was important to expedite the work as much as possible. Besides, the streets are narrow, the roadway being 36 ft. or less, making the space between tracks and curb narrow.

The construction of variable-depth gutters with standard catchbasins at the low points discharging into collecting sewers was considered. This scheme was objectionable on account of the extreme warping of the pavement necessary, the large number of catchbasins required and the resultant cost. In addition the grade would be broken to such an extent that the appearance of the pavement would be appreciably affected. The construction of concrete channels to be covered with continuous iron gratings was also considered, but was rejected on account of the cost, interference with street cleaning and liability to nuisance on account of deposits, ice and obstructions.

A New System of Storm Inlets

The adopted scheme consists of small cast-iron storm inlets of special design, spaced approximately 40 ft. apart, each having a terra cotta pipe connection to a 12-in. drain laid with shallow cover along the curb

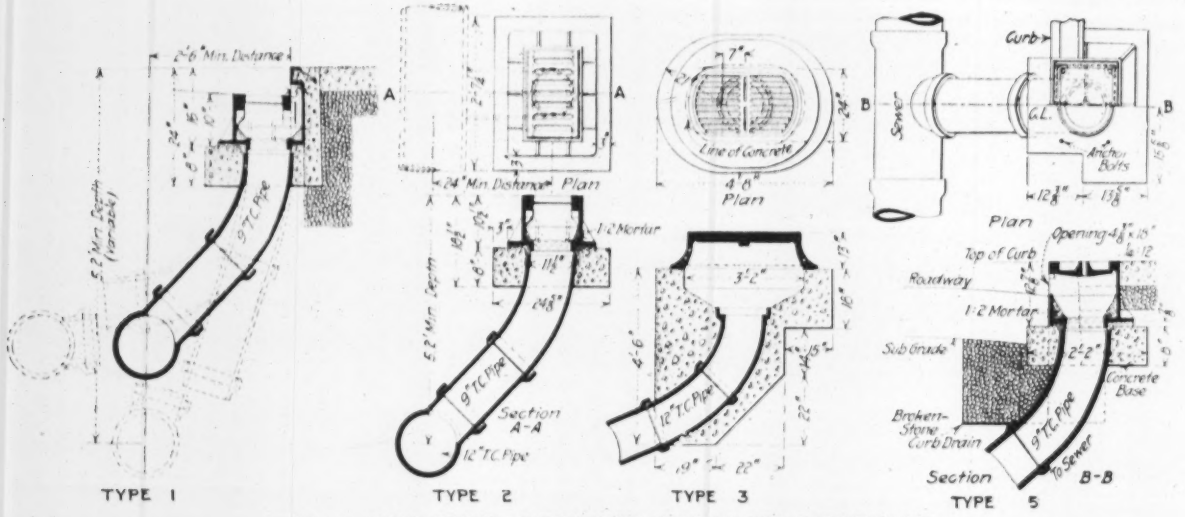

FIG. 4. FOUR TYPES OF THE NEW CURB INLETS, PITTSBURGH

these collecting drains discharging into brick manholes, the outlet of which is trapped with a special casting and which discharge into the existing combined sewers. Four types of special storm inlets were designed.

Type 1 consists of a rectangular iron casting with a waterway 18 in. in length and 2⅜ in. in height in the face of the curb, and an 18x12-in. cast-iron grating also acting as a cover for the box. A circular opening in the base of the casting provides for the discharge into the 9-in. terra cotta pipe. A bead is provided on the interior of the box around the opening so as to retain the mortar filling. The interior of the box around the opening is filled with 1:2 cement mortar, as shown in accompanying detail, Fig. 4. This type of storm inlet has been used where it has been impossible on account of vaults to place storm inlets in the sidewalk area. As will be noted, the terra cotta pipe connection with the inlet box to the collecting drain is very nearly vertical, thus facilitating inspection and cleaning.

Type 2 is designed for use on alleys having a center gutter; with the exception of the omission of the vertical waterway opening, it is quite similar to the casting designed for Type 1.

Type 3 is a special design for greater capacity. Type 5 consists of a box casting set flush with the face of the

curb and provided with a cement-filled iron cover. Wherever possible, this type has been used in preference to the grating type. The waterway area provided in Type 5 is 18 in. in length with a maximum of 4⅜ in. in depth. The lower edge of the vertical opening is curved.

As before stated, the 12-in. tile collecting pipes discharge into manholes having trapped connections with the combined sewers, the trapping of these connections being necessary to prevent emanation of odor and steam from the existing combined sewers to which all other connections are trapped. The manhole trap consists of a casting built in the brick masonry of the manhole and provided with a flange to which is bolted a ⅜-in. steel plate, an asphaltic gasket being inserted between the plate and the flange.

Following are the computed weights of the various castings referred to:

	Type 1, Lb.	Type 2, Lb.	Type 3, Lb.	Type 5, Lb.
Frame	188	178	604	207
Grating	68	71	208	53
Total	256	249	812	260

The contract costs for the various items embraced in the drainage work were as follows:

	Unit Price
262 storm inlets, Types 1 and 5, complete in place, including concrete and cement filling	$20.00
48 storm inlets, Type 2, complete in place, including concrete and cement filling	20.00
3 storm inlets, Type 3, complete in place, including concrete and cement filling	20.00
48 standard brick manholes	35.00
42 special trap brick manholes	40.00
11,700 lin.ft. 12-in. terra cotta pipe drains	.80
1,900 lin.ft. 9-in. terra cotta pipe connections for storm inlets	.75

Based on the foregoing prices the average cost of surface drainage for several typical blocks is $3.33 per lin.ft. of street.

The contractor for the above-described work is the M. O'Herron Co., of Pittsburgh. The work has been executed under the general supervision of Robert Swan, Director, Department of Public Works, and N. S. Sprague, Superintendent, Bureau of Engineering.

Some Recent Legal Decisions of Engineering Interest

In the following paragraphs are given several recent legal decisions which contain matter of interest to engineers and contractors.

War as Affecting Contract for Engineering Material—By the law of nations, all ordinary commercial intercourse between citizens of belligerents, being incompatible with a state of war between their countries, is interdicted.

Supplies consisting of engineering material, coal and numerous other articles had been sold by an Austrian concern to an English company. The English company refused payment on the ground that the state of war between England and Austria discharged the obligation. The Austrian company thereupon brought suit in the courts of the United States, knowing that the English company had property here subject to execution. The District Court, however, held that where the law of both belligerent countries forbids a payment by a subject to a subject of the enemy country during the continuance of a war, such payment will not be enforced by a court of a neutral country, which has acquired jurisdiction of property of the debtor. (Watts, Watts & Co., Ltd., vs. Unione Austriaca di Navigazione, 224 Federal, 188.)

Fear as an Element in Damages—A right-of-way 100 ft. wide was condemned for the erection and maintenance of towers, poles and wires for the transmission of electricity, and the jury in assessing the damages considered the fear of people from the presence of these poles and wires on the right-of-way as depreciating the value of the remaining land. The judgment pronounced on this verdict was reversed by the Supreme Court of Alabama in Alabama Power Co. vs. Keystone Lime Co. Justice D. Graffenreid in his opinion said: "In allowing compensation the law cannot allow any compensation on account of any claimed depreciation of the remaining land which is due to the mere fears of some of the people, which are founded in reality upon their lack of knowledge of the real effect of the line, and which human experience shows is not justified by the facts." (Alabama Power Co. vs. Keystone Lime Co., 67 Southern, 833.)

Tunnel Construction Causes Damage—A street railway company engaged in reconstructing a tunnel under a river under authority from the city damaged the building of an abutting owner by dynamite explosions and by permitting water from the river to flow into an excavation in the street, permeate the soil and undermine such owner's lot. Where expenses incurred by the owner in attempting to brace and protect the building and sustain it during the progress of the work were incurred in good faith and in the exercise of a reasonable and prudent judgment in an effort to reduce the damages, they were recoverable as a part of the damages to the property. (Peck vs. Chicago Rys. Co., 110 Northeastern, 414.)

Engineer's Estimate Necessary Before Letting Contract—A West Virginia law, passed May 24, 1915, requires that proposals for county bridges must be advertised for four weeks in advance of the contract letting and that the County Court must employ a competent engineer to make a thorough investigation and estimate of the cost of building the bridge before awarding the contract.

A taxpayer of Morgan County brought suit to enjoin the County Court and the Luten Bridge Co. from carrying out a contract for the construction of two bridges where these requirements had not been fulfilled. A preliminary injunction was granted by Judge Warren Kittle of the 19th Judicial Circuit, on Sept. 4, 1915, and a motion to dissolve this has been refused by Judge J. M. Wood of the 18th Judicial Circuit, in an opinion in which the constitutionality of the law is sustained.

Employer's Liability in Time of Strikes—In the course of a strike at the factory of the Link-Belt Machinery Co., in Chicago, a foreman of the company, on his way home from the plant, became involved in a quarrel with some of the strike picketers, and while at some considerable distance from the plant and in close proximity to his own residence, quarreled with a bystander, and in the course of the altercation shot him. The wounded man sued the company, and in the lower court was awarded damages to the extent of $9,000. The case was tried a second time and the court then instructed a verdict for the defendant.

On appeal the court sustained the second decision, on the ground that the plaintiff was purely a bystander, and was not connected in any way with the company or with the strike, and that the foreman was neither defending his employer nor any employee at the time he shot the plaintiff. The trouble was apparently entirely a personal one, and the company was not liable.

How the New York State Barge Canal Will Be Operated--II

By William H. Yates*

SYNOPSIS—Power-supply system for the canal-operating equipment described in "Engineering News," Jan 20, 1916. Hydro-electric plants, stations at the Waterford lock flight, gasoline-electric generating stations, and concrete poles.

The article which has already appeared (*Engineering News*, Jan. 20, 1916) on the mechanical equipment required for operating the New York State Barge Canal leads up to the description of the electric-power generating and distributing system.

At most of the locks there was sufficient water available and at proper head so that hydro-electric generating plants were practical and economical. Along the Mohawk River, however, and at a couple of isolated places it was found advisable to generate power from fuel, and gasoline-electric engine units were selected.

Design of Typical Hydraulic Station

The typical power-station equipment consists of two 50-kw. hydro-electric generating units installed in a reinforced-concrete power house, the outward appearance of which fully pays for the effort made to obtain a pleasing appearance. The typical layout was necessarily changed in four cases where one station generates power for operating two or more locks, as noted hereafter.

At most of the locks, water flows from the upper pool through a culvert in the lock wall and is admitted to the wheel pits through yellow-pine headgates hoisted in most cases by a traveling crane of 3 tons' lifting capacity, with which all stations are equipped. The top section of these headgates is an iron casting of special design (see Fig. 18), to which two hoisting chains are attached and which rises 4 in. before the body of the headgates can move. The water thus admitted balances the pressure on the gates.

Turbines of uptodate design were specified and installed. The required efficiency was 75% at approximately 75% turbine gate opening under the normal head, which was defined to be the difference between the elevation of the water surface in the wheel pit near the headgates and the elevation of the water surface in the tailrace near the draft tube. The turbines are all of the Francis inward-flow type with vertical shaft and movable guide-vane regulation. The runners are cast in one piece and are of various diameters, ranging from 23 to 39 in., depending upon local conditions and the available normal head. They have sufficient capacity when running at normal speed and with full gate opening to drive the generators at 15% overload when operating under normal head. The speed in most cases is about 280 r.p.m., ranging from 130 where the normal head is 10 ft. to 600 r.p.m. where the normal head is 35 ft.

VARIATION OF CONDITIONS AT BARGE CANAL POWER STATIONS

Canal.	Lock No.	Normal Head, Ft.	Diameter of Runner, In.	Horsepower	Speed, R.p.m.	Flume
Champlain	6	14	26	88	226	Open flume
Champlain	8	9	39	108	280	Open flume
Erie	33	17	23	95	264	Closed steel flume

Particular attention was paid to the attainment of efficiency not only by good specifications for the turbines,

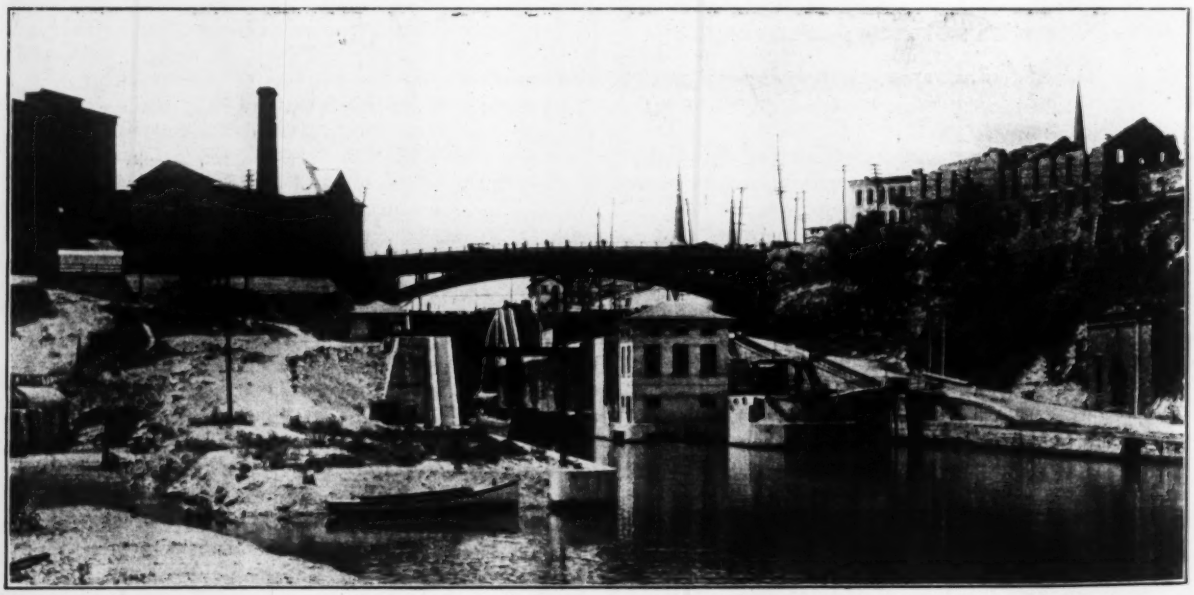

FIG. 13. POWER STATION AT LOCKPORT (LOCK 34, ERIE CANAL) SUPPLYING LOCKS 34 AND 35
Old canal locks at right; five locks of the old canal replaced by two of the new canal having a total lift of 50 ft.

*Consulting Engineer, 52 Wall St., New York City. Formerly Supervising Engineer, Office of State Engineer and Surveyor, Albany, N. Y.

but also by careful planning of hydraulic conditions at the site so that they would be as good as could be made. The turbines installed have been satisfactory and the high efficiency attained, particularly at lock 23 on the Erie Canal (where especial care was taken in the formation of the wheel pits and draft tubes), has justified the effort made.

To insure smooth and reliable operation in service, all moving parts are either of bronze or bronze lined, and the arms operating the shifting ring are so placed that smooth operation must result. The vertical shaft of each typical turbine, direct-connected to the vertical shaft of each generator, is hung from a roller bearing at the top of the generator, where it is readily accessible. An adjustable guide bearing of the lignum-vitæ type is attached to the cover plate of each wheel case.

The speed of each turbine is controlled by an oil-pressure governor of 6,000 ft.-lb. capacity directly connected to the regulating shafts attached to the shifting ring of the wheel case. The speed of the runner can be maintained within 0.75% of normal speed under gradual changes of load. Each governor will open or close the turbine gates in 1.5 sec. Two motor-driven pumps are provided for the governor oil system.

Two direct-current commutating-pole generators, rated at 50 kw. at 250-volts, are installed in each of the typical hydro-electric stations. The vertical shafts previously mentioned have babbitt-lined guide bearings above and below the armature, but are hung from above the generator by a roller thrust bearing which supports the entire load of both the armature and the turbine runner. The thrust bearing and all revolving parts needing lubrication are kept well supplied with oil through the oiling system mentioned later.

The generator windings have special insulation and are protected by an oilproof and waterproof coating. Factory tests, made prior to shipment, were supplemented at the site after installation by a seven-day operation test made prior to acceptance. The revolving parts of the two generators in each station are made interchangeable so far as possible.

Hydro-Electric Station Accessories

Each station has a gravity-feed oiling system. From a filter in the basement, oil is raised by a small motor-driven rotary pump to a distributing tank located about 15 ft. above the station floor on the crane-rail ledge in one corner of the station. From the tank the oil flows through pipes extending through the floor and connecting with sight-feed lubricators attached to the generator thrust-bearing case. Oil overflowing from the thrust bearing is piped to the steady bearing of the generator, to which is attached a combination gear case and oil catcher from which the oil returns to the filter.

The stations are each lighted at night by four 100-watt tungsten lamps and heated by two 4,000-watt heaters. A complete set of station accessories, including a stock of consumable supplies, was furnished by the contractors for the operating equipment, so that when each of the 40 stations was accepted a plant was available fully supplied for at least one canal season's operation. By this plan the state obtained the benefit of wholesale prices.

The entire interior of each power station is painted. To prevent the formation of dust, the floor is painted with gray gloss paint over a filler coat well rubbed in. The side

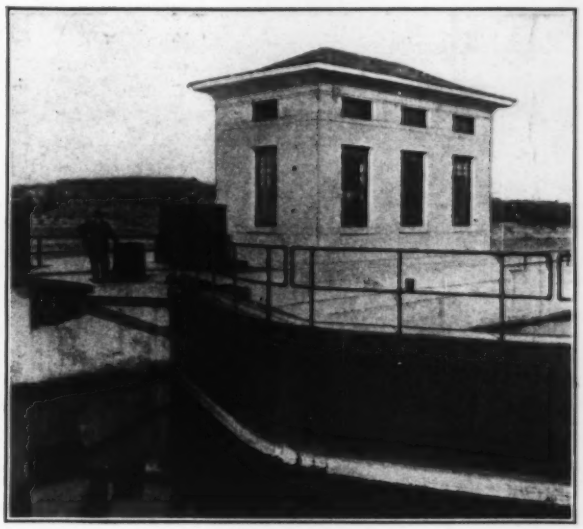

FIG. 14. TYPICAL CANAL POWER STATION

walls are painted the same color to a height of 4½ ft., where a slate-colored band, 2 in. wide, forms a more definite contrast to the dull white of the upper side walls and ceiling. This finish improves the illumination and produces a neat shipshape appearance highly instrumental in encouraging attentive maintenance, cleanliness and neatness.

Where direct current is to be generated in one substation for the operation of another lock besides its own, a series-wound booster-generator was installed to maintain the voltage at the delivery end of the transmission line within limits that will insure satisfactory operation of lights, motors, motor control and other apparatus. The booster-generators are operative between limits of zero to 150 amperes; their rated capacity is 15 kw. at 105 volts. A speed-limit device, attached to the shaft of the booster, is arranged so that it will trip a circuit-breaker, thereby automatically cutting out the motor, which is rated at 25 hp. Ample space for the future installation of a similar unit is provided.

At each lock not adjacent to a power station a distribution cabinet was installed with all the necessary fixtures to receive and distribute current. This apparatus is protected by storm-proof sheet-steel cabinets similar to those housing the control apparatus for the gate machines, the valve machines and the capstans.

Power Stations of the Waterford Flight

Near Waterford, locks 2, 3, 4, 5 and 6 of the Erie Canal, known locally as the Waterford flight, are all within 2 mi. of Crescent dam—a fixed dam across the channels of the Mohawk River near Crescent—where an available head of 20 ft. and an ample water supply permit the generation at one station of sufficient power to operate all five locks.

Adjacent to the dam a reinforced-concrete power station contains three 75-kw. 2,300-volt 40-cycle vertical turbine units, furnishing alternating current which is transmitted to two substations—one near lock 3 and one near lock 5. These substations in turn generate 250-volt direct current which is supplied from them to locks 2 and 3, and 4, 5 and 6 respectively. Each substation contains two motor-generating units, and there is ample

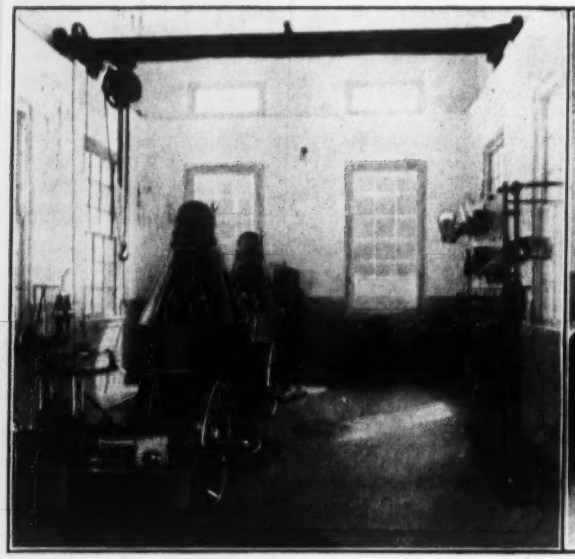

FIG. 15. INTERIOR OF TYPICAL HYDRO-ELECTRIC CANAL POWER PLANT
Lock 3, Champlain Canal. Governor in left foreground

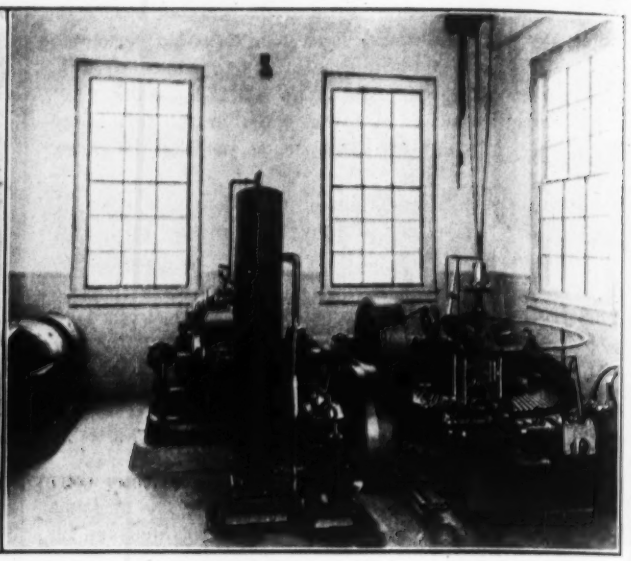

FIG. 16. HYDRO-ELECTRIC STATION GENERATING CURRENT FOR TWO LOCKS
Lock 8, Champlain Canal. Booster generator at left

room for a third. The units each consist of an induction motor directly connected to a direct-current generator rated at 35 kw. at 250 volts.

A telephone system was installed to connect the power station at Crescent dam with the substations near locks 3 and 5 and also with locks 2, 3, 4, 5 and 6, as well as with the two huge guard gates. Similar telephonic communication is provided wherever power is transmitted from one lock to another.

The indoor and outdoor telephone stations are equipped with instruments similar to those used by the New York Telephone Co. (Bell System), so that at any future time the system can be extended along the entire canal and connected to the present long-distance system if this is found to be necessary or desirable.

Thirty-Foot Concrete Poles Poured in Place

In all, 528 reinforced-concrete transmission-line poles were built. Some of these were set between Crescent dam and lock 2, Erie Canal, a distance of two miles, and some at three locations where a single power station generates energy for two locks.

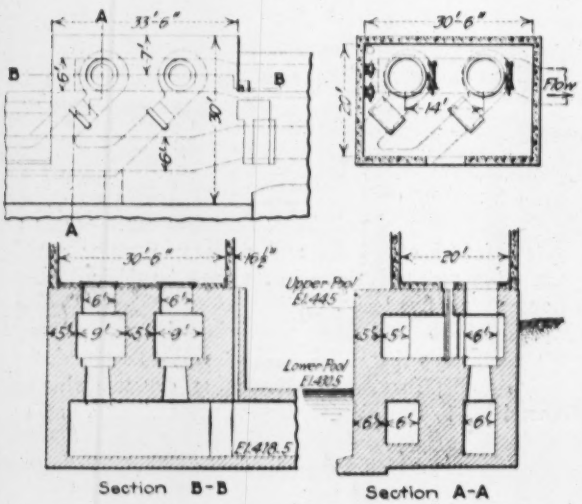

FIG. 17. TYPICAL ARRANGEMENT OF WHEEL PITS

The poles, which are square in cross-section and have a corrugated deformed bar 1⅛ in. in diameter in each corner for reinforcement, were made in three lengths, 30, 35 and 40 ft., and are unusually heavy. They were designed for the usual transmission-line service conditions and further for a coating of ice on the line with one-third of the wires on one side down. The allowed intensities of stress, 500 lb. per sq.in. in the concrete and 12,000 lb. per sq.in. in the steel, are lower than some designers have permitted under the same or even less severe assumed conditions.

Each pole was equipped with galvanized angle-iron cross-arm supports and galvanized-iron pole steps that can be removed at will, because they are secured by metal helixes placed in the forms before pouring.

Pouring in place was necessitated by the rough nature of the ground traversed and the distance of the line from frequented highways, and was facilitated (a) by the preliminary casting of an independent socket base of comparatively lean concrete circular in cross-section, about 5 ft. deep and providing a depth of concrete of 12 in. under the butt of the pole, and (b) by an ingenious method of erection and a portable plant devised by J. F. Butler and Paul Blake, of the contractors' corps of engineers.

The precast concrete socket base of lean concrete exactly filling the excavation made possible the pouring in place of these large concrete poles. After the base had set the pre-assembled metal reinforcement was raised with a wrought-iron pipe about 3 in. in diameter. A full-length square wooden form was then hoisted in position and guyed with galvanized wire (required as permanent equipment for some of the poles but used temporarily to guy the form). Each form was made of dressed lumber and coated with form oil. The novel feature of the form was that one side was left open to be closed with movable panels about five feet long as the form was filled. A split form was avoided by using removable pole steps.

Five forms were used. Each form was carried to its new position on a light long-reach lumber wagon capable of traveling over rough ground. Stripping and erection of forms were accomplished by the pair of light shear legs above mentioned. The portable concreting plant, carried on a light farm wagon easily driven over rough ground, consisted of a mixing board, water-barrels, pails and other mixing tools and included three coal scuttles or hods used with much success to hoist and pour the concrete as the form was filled.

Gasoline-Electric Generating Stations

At each of the eight Mohawk River locks, adjacent to the eight movable dams, the installation of a hydro-electric station was precluded by the fluctuations in river level during the canal season (which is usually from May 15 to Nov. 15). After studying the several possible methods of obtaining power for these locks, it was found that the most reliable arrangement would be to generate current at each lock in a complete and independent plant, free from all service interruptions, as well as from transmission-line and other troubles.

This plan necessitated fuel-burning stations, and gasoline-electric units proved the most economical and convenient under the conditions prevailing. On shore near each lock but above highest recorded water, a concrete station building was constructed similar in appearance to the hydro-electric stations (a typical one is shown in Fig. 19), and in it were placed two 25-kw. generating units.

Each machine alone is capable of carrying the full load from the present lock and movable-dam gates, and space is provided for an additional similar unit, so that ample power may be available to operate an additional lock whenever one is installed. (The motor equipment for each lock resembles that previously described and is composed of four 7-hp. gate-machine motors, four 3-hp. valve-machine motors and two 20-hp. capstan motors. In addition to this lock equipment there are two 12-hp. winch-motors on the superstructure of each movable dam, each capable of operating it. Both the lock and the dam are lighted at night from this plant.)

The engine is of the inclosed four-cycle single-acting vertical type with four water-jacketed cylinders. It is designed to drive the generator, to which it is directly connected, at 25% overload. The normal speed, 560 r.p.m., is maintained practically constant at all loads by a governor, although a maximum variation of 3% from

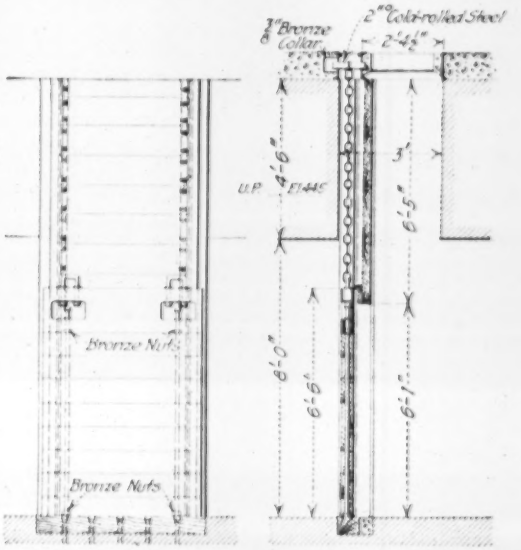

FIG. 18. HEADGATES FOR HYDRO-ELECTRIC STATIONS

no load to full load was permitted. The generators were wound for 250-volts, direct current. These generating units were originally developed by the makers for service elsewhere and have been used successfully for years. Similar units installed by the United States Government in the Philippine Islands have given good service. Each unit was tested at the factory prior to shipment, and this test was supplemented by a service test after installation.

Gasoline is supplied to each unit by a plunger pump from a 1,000-gal. storage tank located underground outside the station and below the engine level. A forced-feed oiling system supplies oil under pressure.

FIG. 19. TYPICAL GASOLINE-ELECTRIC POWER STATION

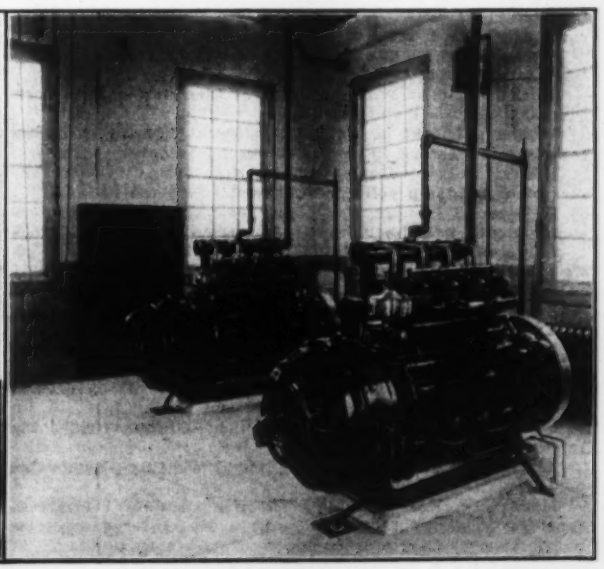

FIG. 20. INTERIOR OF GASOLINE-ELECTRIC STATION

Cooling water is supplied from a reinforced-concrete cooling tank located outside the station, filled by gravity from the upper lock pool and discharging into the lower pool. A rotary pump on the engine shaft supplies the engine with cooling water at a rate regulated to control the jacket-water temperature. A hot-water radiator connected with the discharge pipe can be supplied with hot water whenever it is desired to heat the station. The interior finish of these isolated stations is like that of the hydro-electric plants. The general equipment covered consumable supplies sufficient for one canal season, as in the other plants.

Contractors for Operating Equipment

The general contracts for the lock-operating equipment, power plants, etc., were taken jointly by the MacArthur Bros. Co. and the Lord Electric Co., of New York City. The operating equipment for locks 1, 2, 3 and 4 of the Cayuga and Seneca Canal is being installed by Lupfer & Remick, of Buffalo, N. Y.

After the contracts were awarded, the engineering departments of the general contractors made careful investigation of all the leading manufacturers of electric machinery and of special machinery and supplies, and as a result selected the following list of manufacturers as being in their opinion best suited, all things considered, to supply the respective parts:

General Electric Co., Schenectady, N. Y.—All motors, generators, arc lamps, switchboards and control systems.

Hyde Windlass Co., Bath, Me.—All lock-wall type valve machines.

Wheeling Mold and Foundry Co., Wheeling, W. Va.—All gate machinery and cabin-type valve machinery.

Camden Water Wheel Works (now the Hydraulic Turbine Corporation), Camden, N. Y.—All hydraulic equipments, including waterwheels and headgates, for contracts 92 and 94.

S. Morgan Smith Co., York, Penn.—All hydraulic equipments, including headgates and valves, for contract 93.

Lombard Governor Co., Ashland, Mass.—All waterwheel governors of the oil-pressure type for all contracts.

James McKinney & Son, Albany, N. Y.—All steel cabinets for control panels, gate and valve recesses, centers of distribution and capstan-control panels. Also structural steel for power houses on contract 93.

The Maine Electric Co., Portland, Maine—All electric capstans, with the exception of motors and controls, for all contracts. Also complete reconstruction of 16 movable-dam winches on locks 8 to 15, inclusive, Erie Canal.

Standard Underground Cable Co., New York City—All rubber-insulated, lead-covered and armored cables included in all three contracts, a total of over 350 tons.

Safety Armorite Conduit Co., Pittsburgh, Penn.—115 tons "Galvaduct" conduit.

Sprague Electric Works of General Electric Co., New York City—All flexible metal conduits.

Wonham, Sanger & Bates, New York City—34 three-ton traveling cranes and 32 trolley blocks for machinery cabins.

Electric Railway Equipment Co., New York City—400 tubular-steel arc-lamp poles with special bases and fittings.

De Veau Telephone Co., New York City—Private intercommunicating telephone systems between Erie locks 2 and 6 and Crescent dam; locks 7 and 8, Champlain; locks 29 and 30, Erie; locks 32 and 33, Erie; locks 21 and 22, Erie; Erie lock 21 to Junction lock.

Burt Manufacturing Co., Akron, Ohio—Oiling systems for all hydro-electric stations.

Macbeth-Evans Glass Co., New York City—Fresnel lenses for signal lanterns on cabinets and machinery cabins.

Hay Foundry and Iron Works, Newark, N. J.—Structural steel for power houses, contracts 92 and 94.

Ludowici-Celadon Co., New York City—Glazed vitrified tile for roofs of power houses.

Richmond Screw Anchor Co., New York City—Removable pole-steps.

MacArthur Bros. Co.-Lord Electric Co.—528 reinforced-concrete poles for transmission line; 39 reinforced-concrete power houses; 32 reinforced-concrete machinery cabins.

Installation of all electrical work and machinery was provided by the manufacturers mentioned.

Substantially all the work described in this and the preceding article was contracted for and practically completed and much general construction was done during the two administrations of former State Engineer J. A. Bensel. The Special Deputy State Engineer during that period was Alex E. Kastl, in charge of Barge Canal construction. The following gentlemen composed the Board of Consulting Engineers: Joseph Ripley, Mortimer G. Barnes, William H. Burr, George S. Greene, Jr., and T. Kennard Thomson.

The contract plans and specifications providing for this equipment were prepared under the writer's direction. During their preparation C. C. Egbert, Consulting

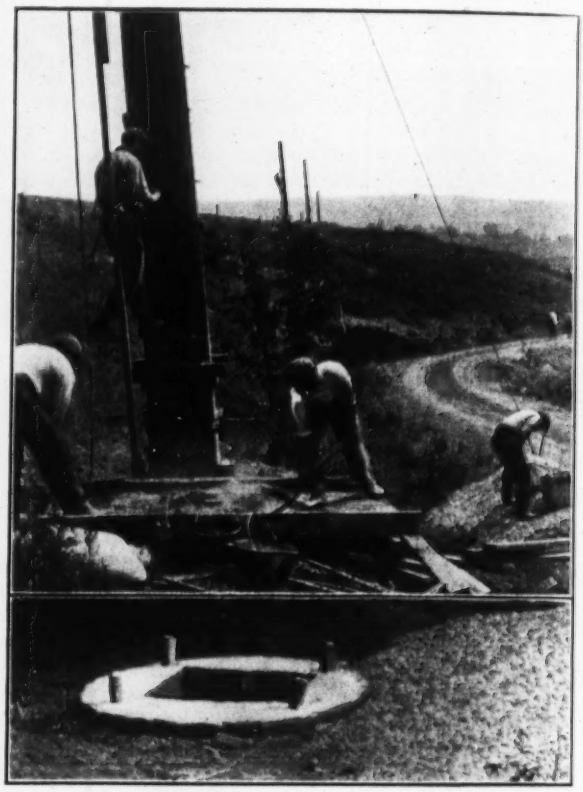

FIG. 21. MOLDING REINFORCED-CONCRETE POLES; CONCRETE BASE READY FOR POLE

Engineer of Niagara Falls, assisted in a consulting capacity as expert in electrical designs. C. H. MacCulloch, Resident Engineer, was in immediate charge of the assistant engineers who prepared the detailed plans.

Barge Canal construction work is carried out under the immediate direction of three Division Engineers. Under former State Engineer J. A. Bensel the following officers served: Western Division, E. J. Govern; Middle Division, Edwin Styring; and Eastern Division, D. B. La Du.

For courtesies extended in furnishing drawings and photographs, acknowledgment is made to the present State Engineer and Surveyor, Hon. Frank M. Williams, and to William B. Landreth, Deputy State Engineer. D. B. La Du is now Special Deputy State Engineer. The present Division Engineers are: Western Division, F. P. Williams; Middle Division, Guy Moulton; and Eastern Division, George Williams.

Some Radical Changes in Brick-Pavement Construction

By P. C. McArdle*

SYNOPSIS—The history of so-called monolithic brick-pavement construction, and how the writer has carried some of its principles to conclusion. Experimental pavement with brick laid on very shallow concrete base (2½ to 4½ in.). Some conclusions as to causes of brick-paving failures.

On Nov. 6, 1914, the writer, as Acting Chief State Highway Engineer, went from Springfield to Paris, Ill., to make the final inspection on Sections A and B, state-aid roads in Edgar County. These two sections of road were of brick on a 4½-in. concrete base with a 1-in. sand cushion laid under the time-honored specifications. There were present W. T. Blackburn, of the Dunn Wire-Cut-Lug-Brick Co., Allan Jay Parrish, contractor, and R. L. Bell, Division Engineer, State Highway Department.

The defects usually found in brick pavements were the topics of discussion. I suggested that a grouted-brick pavement acted as a 4-in. brick slab; that the so-called sand cushion could no longer fill the function which it did when the base was of brick laid flat-wise, or was composed of gravel or sand and the joints sand filled,

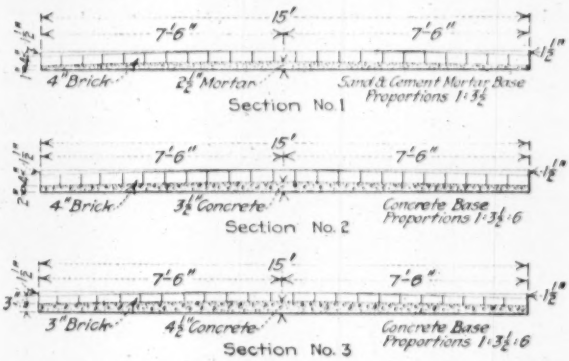

FIG. 1. CROSS-SECTIONS OF EXPERIMENTAL BRICK PAVEMENTS NEAR DANVILLE, ILL.

and that I would like to see some grouted-brick pavements laid down in the soft concrete base without a sand cushion. After a little discussion, permission was given by the State Highway Department to lay an experimental section of 400 ft. side by side with the sand-cushion type.

This pavement, using a thin sand-and-cement cushion, was laid in the spring of 1915. Other pavements of the same type were laid in the township and in the City of Paris, Ill., about the same time. Contracts for two miles of this type were let, one mile of which was recently completed at Paris and another for 16,200 ft. was let at Monticello, Ill., by the State Highway Department.

My first thought was that the brick would rapidly settle down unevenly in the wet concrete, and I suggested that this was the only practical obstacle. After having placed a section of pavement without the use of a dry-mortar cushion, as frequently described in the technical press and now specified in many sections, there is no question in my mind that such a mortar cushion is a needless expense and perhaps a detriment.

My first fear has not been justified in practice. I have found it practicable with the use of an ordinary templet to level off the concrete to true grade and to lay the brick in the concrete base without appreciable settlement, as described later. A light hand roller completes the leveling of the brick surface to true grade. The use of a dry mortar of very lean proportions undoubtedly places a line of weakness between the concrete base and the brick surface.

Advantages of Monolithic Construction

The laying of the brick monolithic slab on country highways reduces the cost of the pavement by eliminating altogether the concrete curb, the longitudinal bituminous joint and the sand cushion. Aside from the added carrying strength of monolithic construction, it has the important advantage that a pavement so constructed may be thrown open to traffic from 10 days to two weeks sooner than one placed on a sand cushion, and the still more important advantage of considerably lower cost. It justifies a thinner concrete base than is possible with the sand-cushion type of brick construction.

The University of Illinois is conducting a series of experiments on these types which should prove interesting and instructive.

California is surfacing its main highways with a uniform 4-in. concrete pavement. Illinois, Wisconsin, Michigan, New York and Massachusetts are all building pavements 6 to 8 in. in thickness. What justification is there then for requiring a 4- or 6-in. base for a 4-in. grouted-brick pavement, making the road an average of 8 or 10 in. thick? A 4-in. concrete road gives satisfaction in California and a 6-in. concrete road gives satisfaction in Illinois, Wisconsin, Michigan and elsewhere. A 4-in. properly grouted brick pavement on a thoroughly drained, puddled and rolled subgrade should give more lasting service than a concrete road of the same thickness; require less maintenance; give a full return on the investment, and prove amply heavy for at least 90% of our country highways.

The one danger to any type of hard surface is the use of lugs on tractor wheels. Injury from this cause may be obviated by a legal requirement to compel tractor owners to use the earth shoulders, remove the lugs or put liners between the lugs when using any type of hard road.

Experimental Brick Pavements with Thin Bases

Recently the Danville Brick Co., at my suggestion and under my direction, constructed an experimental brick pavement 200 ft. long, 15 ft. wide, of monolithic construction, divided into four sections each 50 ft. long. This pavement is on one of the heaviest traffic roads immediately adjoining the City of Danville. The four sections are described as follows:

*Superintending Engineer, Vermilion County, Danville, Ill.

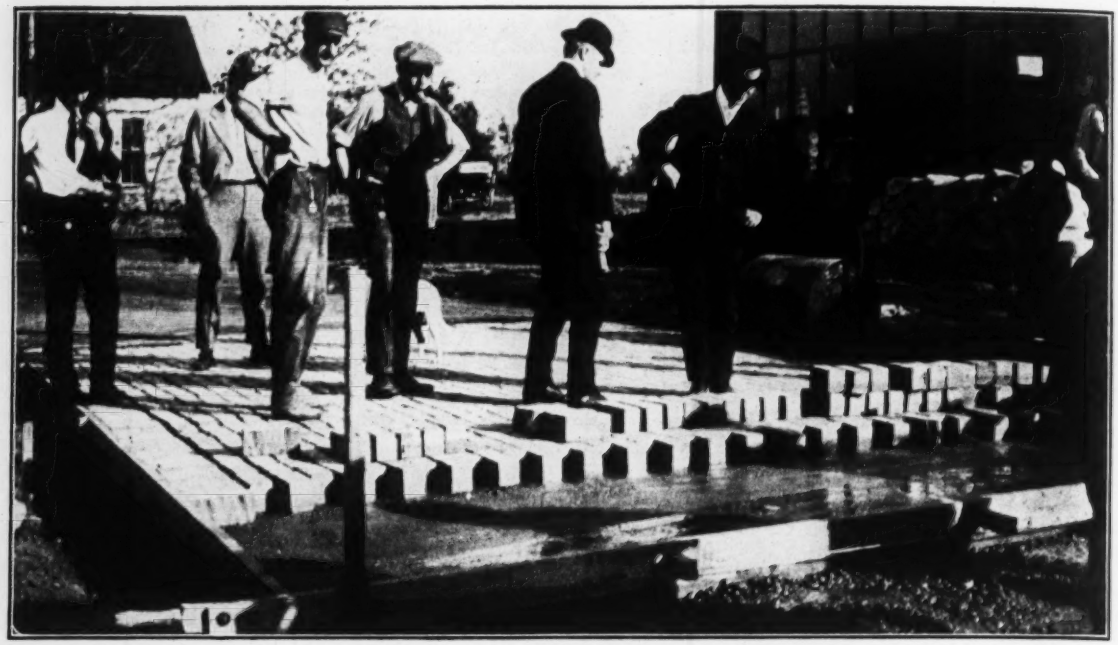

FIG. 2. LAYING BRICK ON EXPERIMENTAL BRICK ROAD, DANVILLE, ILL.

Type No. 1—A 4-in. brick on a 1 : 3½ cement mortar base, 1 in. thick at the sides and 2½ in. at the center. The total thickness of the slab is 5 in. at the sides and 6½ in. at the center.

Type No. 2—A 4-in. brick on a gravel concrete base mixed 1 : 3½ : 6, which is 2 in. thick at the sides and 3½ in. at the center. The total thickness of the slab is 6 in. at the sides and 7½ in. at the center.

Type No. 3—A 3-in. brick on a gravel concrete base mixed 1 : 3½ : 6, which is 3 in. thick at the sides and 4½ in. thick at the center. The total thickness of the slab is 6 in. at the sides and 7½ in. at the center.

Type No. 4—The same as No. 2 except that the bricks are laid lengthwise.

On all of these types except type No. 3, a header course of full-sized brick was laid for curbs.

This experimental road was completed on Oct. 25 and was thrown open to traffic on Nov. 22, 1915.

The concrete and grout were machine mixed. The gravel was obtained from the Interstate Sand and Gravel Co., Covington, Ind., and was graded from 1 in. down to ¼ in., and the sand from ¼ in. down.

These sample types of brick pavement embody the original idea of the writer of placing brick directly on the concrete base. It is the only road the writer is aware of which is constructed in this way. So far as practicability is concerned, there was no difficulty experienced in construction and no apparent necessity for a dry-sand mortar; even with type No. 1, where the brick were laid on a wet-mortar bed, the method worked perfectly. This sample pavement should demonstrate the practical utility of a properly cement-grouted brick pavement on a very thin base. The accompanying sketch shows cross-sections of the pavement as laid.

Discussion of Brick-Pavement Failures

A glance over the field of brick construction discloses the fact that failures from blow-ups, crushing, longitudinal and transverse cracking do not or have not occurred in brick pavements with sand-, tar- or asphalt-filled joints with bricks laid on a gravel, a macadam or a concrete base and sand cushion. Successful examples of these types which have been in service 20 yr. or more and are now in good condition may be found in Dixon, Clinton, Springfield, Freeport, Danville, East St. Louis, Belleville, Champaign and elsewhere in Illinois.

I think it may also be safely stated that failures such as buckling, crushing or blow-ups of grouted pavements have been due to expansion of the pavements, imperfect expansion joints, no joints at all, sand cushion improperly placed, or a combination of poorly placed cushion and indifferent expansion joints.

It is a matter of observation that these defects do not show during the first year, but only after a few years of service. Two samples of grouted pavements now under observation showed no sign of failure until the third year of service, and the deterioration seems to increase very rapidly. Both these pavements are laid on a concrete base with sand cushions, flush curbs, with so-called expansion joints along each curb and with transverse joints at intervals of 50 ft. Blow-ups, buckling and crushed spots appear frequently in both. Examination of these pavements discloses a 2½-in. sand cushion, expansion joints that do not exceed 1½ in. of depth, and grout filler of the same depth. The failures are undoubtedly due to repeated internal stresses through expansion of the pavement.

Probable Advantages of Monolithic Construction

Whenever a grouted pavement is laid on a sand cushion on a concrete base, two slabs are provided, one of concrete and one of brick, separated by a sand cushion. It is admitted that it is exceedingly difficult uniformly to compact a sand cushion. The result is that the brick slab is called upon to bear practically the entire traffic load, the imperfect cushion acting as a line of weakness between the two slabs.

The effect is something like this: At maximum temperature the pavement expands, butts against the curbs

and rises from the cushion in spots resembling waves. Heavy loads come on the pavement. The pavement is already stressed by compression; the load finishes the job. Longitudinal or transverse cracks appear and are noticed when contraction comes. Is it not more practicable and more certain of results to strengthen the brick slab by a thin concrete base and leave the earth foundation to furnish the necessary resiliency?

It cannot be said at this writing that monolithic brick pavement construction is entirely satisfactory. It must prove itself by the test of time and service. It bids fair, however, to push aside other classes of brick-pavement construction, and if not successful when properly placed, we may well return to the sand-, tar- or asphalt-filled, sand-cushion type of construction with a suitable concrete base, the thickness depending on the traffic.

Water for Fires at Hartford*

By Caleb Mills Saville†

The average daily consumption of water in Hartford is at a rate of about 9,500,000 gal., which, with the number of consumers estimated at 136,000, gives a daily per capita consumption of 70 gal. All of the services are metered except those intended solely for fire-protection purposes. A recent canvass of public uses of water and a comparison of venturi-meter records from the supply lines with the amount of water paid for have resulted in an estimate of the manner in which water is disposed of in this city. These figures, together with estimates by the late Dexter Brackett (in his report made in 1894 on water consumption in the Boston Metropolitan District), are given in Table 1.

TABLE 1. DISTRIBUTION OF PER CAPITA WATER CONSUMPTION

Use	Hartford Estimate of 1915 Gal. per Capita	Per Cent. of Total	Brackett Metropolitan Estimate, 1894, Gal. per Capita
Domestic	34	48.6	35
Manufacturing	19	27.1	35
Public	3	4.3	5
Unaccounted for	14	20.0	25
Total	70	100.0	100

The impression of the general public is that vast quantities of water are used in putting out fires. This idea is very erroneous. The total amount of water so used is comparatively small, but the rate of demand for short periods is often very great—so great, in fact, that in cities of 100,000 to 150,000 population a reasonable requirement for fire-protection service often equals or exceeds the maximum hourly rate of draft of an ordinary day.

The total amount of water used by the Fire Department in Hartford in 1914 was about 7,000,000 gal., or 0.14 gal. per capita per day. Of this quantity about one-half was used in the maintenance of 16 stations, including washing of hose and apparatus. The remainder was used in extinguishing fires. The fire consumption and related figures for 1914 are shown by Table 2.

Of the 105 alarms at which water was used, three or more streams were in service at only 16. There were seven calls at which five or more streams were used, four at which nine or more were used and one at which 13 streams were in service. Table 3 presents an analysis of the seven calls in which five or more streams were in service.

These seven fires used a total of 2,182,190 gal., or about two-thirds of the entire amount used to put out fires, leaving 1,117,810 gal. to be used by the other 98 calls, or an average of about 11,400 gal. per fire call.

TABLE 2. USE OF WATER AT FIRES, HARTFORD, CONN., 1914

Total actual fire alarms	628
Number of fire calls at which water was used	105
Number of times pump service was available	63
Number of hose streams in use, average	2
Length of hose line, average, ft	380
Usual size of nozzle, diameter, in	1 to 1¼
Average hydrant pressure in service, lb	60 to 80
Average pump pressure, lb	100 to 200
Total amount of water used, gal	3,300,000
Value of property included in the fires	$7,973,100
Insurance thereon	$3,348,310
Insurance loss	$374,538
Uninsured loss	$14,590

Duration of service: 15 min. for 50 fires; 15 to 30 min. for 25 fires; 30 to 60 min. for 15 fires; 1 to 1½ hr. for 11 fires; 2½ to 4 hr. for 2 fires; 4 to 6 hr. for 2 fires.

The following data relate to a fire call which may be classed as ordinarily severe for a city similar to Hartford: On Dec. 13 at 2:15 a.m. an alarm was rung in for a fire in the building occupied by Smith & Northam on State St., Hartford. The building was supposed to contain a considerable quantity of hay and was located in a district where serious results were apprehended if the fire was not quickly controlled. Besides other apparatus, four steamers responded. Two of them were of the large self-propelled type, capable of delivering 1,200 gal. per min. each. The other two were of the ordinary type, one of 900, the other of 600 gal. per min. capacity. In addition the fire pumps at the near-by car barns of the Connecticut Co. were put in service. The hose-line system consisted of the following lines: Two 3-in., four 2½-in. and three 1½-in. lines. The venturi meter on the supply main at the effluent gate house indicated the total amount of water used at this fire as about 350,000 gal. The rates of draft in excess of the ordinary consumption expressed in thousand gallons per hour for successive 10-min. intervals were as follows: 125; 190; 200; 240; 195; 160; 170; 170; 110; 130; 140; 100; 70; 30; 20; 30.

It is of interest to note in this connection that in a city of 135,000 inhabitants with full fire and police protection there is a possibility during any year of at least five fire calls any one of which may require from 150,000 to 650,000 gal. of water drawn at rates up to nearly 7,000,000 gal. per day in excess of a maximum ordinary flow. Also that this rate may be maintained for from two to three consecutive hours. In view of the Baltimore, Chelsea and Salem conflagrations and the ordinary fire demands of a city of the size of Hartford, as shown in Table 3, it seems clear that it would be well for many towns and cities to look closely into the capacity of their supply mains.

TABLE 3. ANALYSIS OF SEVEN CALLS USING FIVE OR MORE STREAMS AT HARTFORD, CONN., IN 1914

Date, 1914	No. of Streams 2½-In.	No. of Streams 3-In.	Av. Time in Service Hr.	Av. Time in Service Min.	Equiv. No. 250 Gal.-per-Min. Streams	Estimated Total Amount Water Used, Gal.
Jan. 20	9		4	20	9.5	613,370
Feb. 21	11	2	2	35	19.1	648,380
Feb. 26	8	2	2	20	12.5	426,530
May 23	5			30	4.5	90,770
Dec. 4	3	2	1	25	6.7	151,220
Dec. 4	7	2	1	25	11.7	239,670
Dec. 18	5			55	9.3	67,250

*Condensed from a paper read before the New England Water-Works Association, Dec. 8, 1915.

†Chief Engineer, Board of Water Commissioners, Hartford, Conn.

Exports from the United States for the ten months ending Oct. 31, 1915, were valued at $2,860,515,000. Imports during the same period were valued at $1,451,267,000. The excess of exports over imports for this period were $1,409,248,000. In the same period of 1914 the excess of imports over exports was only $114,000,000.

Reinforced-Concrete Street Viaduct at Denver, Colo.

SYNOPSIS—A reinforced-concrete viaduct designed to permit free expansion and possible unequal settlement of foundations under construction at Denver, Colo. Total length, nearly 8,500 ft. Massive structure designed to safely carry very heavy rolling loads; cost of construction approximately 15% less than the estimated cost of a similar structure of steel. Most novel feature in the design, the division of the structure into towers connected by suspended spans, the suspended spans being supported by steel eye-bars from cantilevers projecting from the towers on either side. Unusual pains being taken in the selection, mixing and placing of the concrete materials, with a view to securing the greatest possible density in the resulting concrete.

A residence district containing approximately one-fourth of the population of the City of Denver and known as the North Side is separated from the business section by a low-lying district traversed by the Platte River and occupied chiefly by railroad tracks and industrial plants. To afford direct passage across this section and to avoid railway grade crossings, there are in existence three viaducts, located at 14th, 16th and 20th St. respectively. Since the district served by these viaducts is steadily increasing in population, it was decided two years ago to build another viaduct some three-quarters of a mile south of the old ones and the work was placed in charge of Herbert S. Crocker, Consulting Engineer, of Denver. After careful study of the local conditions, it was decided to build the new structure of reinforced concrete instead of steel, except at the crossing of the South Platte River and at some of the crossings over railway tracks, where the lengths of the necessary spans made the use of steel instead of concrete advisable.

The final cost of the structure will be about 15% less than if it had been built of steel. While this is based on the cost of steel structural work in Denver, which is considerably higher than in the East, it is to be remembered on the other hand that at the time the design was made for the viaduct, prices of steel were phenomenally low and the difference would be considerably greater were present prices to be used.

FIG. 1. CONSTRUCTION VIEW OF COLFAX-LARIMER REINFORCED-CONCRETE VIADUCT AT DENVER

The cost of the structure including the materials (the cement and steel are furnished to the contractor) is approximately $18 per cu.yd. The quantities of concrete per linear foot and the approximate cost of the same per linear foot of the viaduct above foundations are as follows:

	Width Over All, Ft.	Length, Ft.	Cu.Yd. Concrete per Lin.Ft.	Approx. Cost per Lin.Ft.
West Branch	68.25	2,900	4.7	$85
Larimer Branch	48.5	2,430	4.0	72
East Branch	38.5	2,642	2.5	45
Colfax Approach	36	507	..	...

In plan the new viaduct is of X shape, and it may really be considered as two viaducts meeting at an angle.

FIG. 2. UNDER SIDE OF WEST BRANCH VIADUCT

The different sections are of different design according to the traffic which they have to carry. The West branch of the viaduct is 68 ft. 3 in. wide, the space on the structure being allotted to a 34-ft. roadway, a 6-ft. sidewalk and a double-track electric car line, separated by a curb from the roadway and sidewalk, as shown in Fig. 3. The Larimer St. section is 48 ft. in width, with double tracks for electric cars in the middle of a 40-ft. roadway. The East Branch carries no street-car tracks and has a total width of 38 ft. 6 in.

Assumed Loadings and Stresses

In designing the structure, cars of 60 tons weight are assumed for the electric-railway tracks plus 25% allowance for impact. This is an exceedingly heavy weight for electric street cars in view of the present movement to reduce the weight of street cars. There is, however, a considerable mileage of interurban electric lines entering Denver, over which unusually heavy cars are now run. It was deemed necessary to proportion the viaduct so that cars of this type might at any time be routed across it. The 60-ton car assumed is carried on two four-

wheeled trucks, spaced 27.5 ft. c. to c., the truck wheels spaced 6.3 ft. c. to c., and the distance between end trucks of adjacent cars being 23.5 ft. Loading on both the roadway and sidewalk is assumed at 100 lb. per sq.ft. plus a concentrated load produced by an 18-ton road roller. In computing the stresses from these loads, it

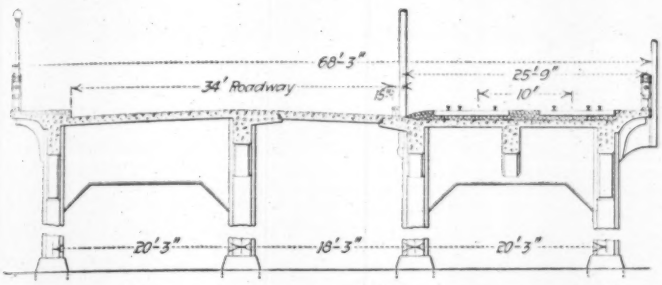

FIG. 3. CROSS-SECTION OF WEST BRANCH VIADUCT
Note provision for expansion movement at central slab

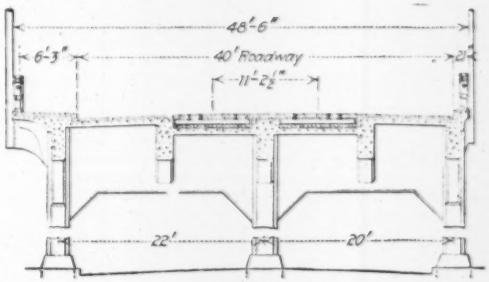

FIG. 4. CROSS-SECTION OF LARIMER BRANCH VIADUCT

was found that the road roller alone produced the maximum moment and shear in the floor slabs, while for the girders the maximum stresses were produced by the combined effect of the roller and the 100-lb. uniform floor load. The computation of stresses is simplified by considering the total floor as carrying the uniform load of 100 lb. per sq.ft., and adding to this one-half of the load produced by the concentrated weights on the road roller. This was found to be much simpler than the usual method of applying the total roller load and adding a uniform loading of 100 lb. per sq.ft. on the area surrounding the roller.

In designing the structure the following maximum unit stresses were assumed: Concrete in compression in beams and slabs, 650 lb. per sq.in.; concrete in columns for direct stress, 400 lb. per sq.in., and for direct stresses in combination with wind and traction stresses, 700 lb. per sq.in.; concrete in shear for beams and slabs with horizontal reinforcing only, 40 lb. per sq.in.; concrete in shear in beams and girders with web reinforcing, 120 lb. per sq.in.; bond stress between steel and concrete, 80 lb. per sq.in.; steel reinforcement, 16,000 lb. per sq.in. for tension. In the design of the columns, twelve plain round rods were used for the main reinforcement, and a hooping was used of ¼-in. square twisted rods spaced 6 in. apart. Nearly all the reinforcing steel used was of square twisted bars. Where the stresses were concentrated, however, by the connections to the suspended slab hangers, round threaded rods were used for reinforcing, as shown in Fig. 6. By the use of cold-rolled threads a greater net section was obtained at the root of the thread than could be obtained from a cut thread unless the rods had been upset.

Provision Allowed for Expansion

In deciding upon the general type of design, involving suspended spans between fixed towers, consideration was given not only to the ordinary expansion and contraction due to temperature changes, etc., but to possible movements due to unequal settlement of the viaduct foundations. While there is nothing that would be classed as very bad ground for foundations in the district crossed, there is considerable variation in the character of the ground. It was therefore determined to design the structure as a series of independent towers connected by spans carried on steel eye-bars and pins so as to permit free lateral motion. In order not to needlessly multiply expansion joints in the roadway, the suspended spans are held at one end by making the roadway slab continuous over one of the flexible link joints. In the completed structure, therefore, provision is made for free longitudinal movement in every second span, or at intervals of approximately 80 ft. That this provision is also effective in permitting the structure to adjust itself to unequal column settlement has been demonstrated by the actual settlement of several of the columns due to percolating water reaching their footings and softening the clay substratum.

In one extreme case a bent settled some 6 in. without developing any cracks in the supported superstructure, thus giving a practical demonstration of the adaptability of the design to unequal settlement. This settlement, while momentarily alarming, is such that it can be compensated for at a small expense and the danger of its recurrence is obviated by prompt action taken to protect the footings immediately upon its discovery.

The weight of the longest suspended span of reinforced concrete is about 120 tons. Some question may possibly be raised as to the introduction in a concrete structure of these steel members not incased in concrete, the life of which may be expected to be shorter than that of the reinforced concrete itself.

The necessity for renewing these steel members, however, is remote in the altitude and climate of Colorado, where years of exposure of steelwork of bridges reveals but slight rust and very little corrosive action due to the presence of sulphur in engine smoke. Under these conditions it was considered unnecessary by the designers to make any special provisions for concrete incasement of metal parts nor to do anything except to apply three coats of red lead paint and incase the exposed steelwork within cast-iron fascia plates, these latter being used for appearance as well as for protection of the steelwork against the elements.

Additional provision for free movement is made in that section of the viaduct which has four supporting columns to each bent. As shown in Fig. 3, the central floor slab between the two rows of interior columns is supported by protecting cantilevers.

While the slab rests on Z-bar seats, it is tied to the cantilever projections permitting vertical movement at the joint without danger that the slab will slip from its bearing. This arrangement prevents cracks occurring elsewhere than at the place thus provided. It was, as

previously described, in this west section of the viaduct that settlement took place.

In the Larimer St. section there are three columns to each bent, and here the cross-girder is continuous over the three supports. In one case on this section it was necessary to make the longitudinal girders also extend over three supports. In order to guard against settlement and possible cracks in this section, piles were driven under all pedestal footings.

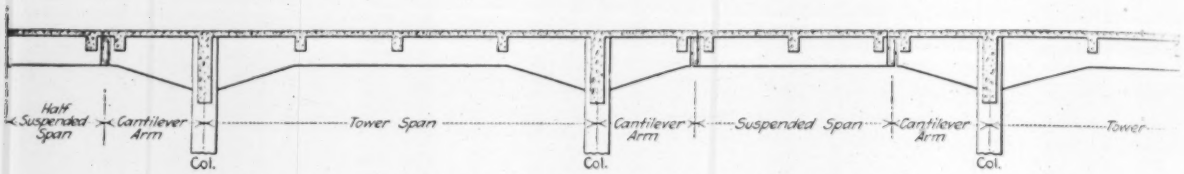

FIG. 5. DIAGRAM ILLUSTRATING ARRANGEMENT OF TOWERS AND SUSPENDED SPAN

The usual span length on the concrete viaduct is about 40 ft., but some of the girders are as long as 54 ft. The street-railway tracks, when placed on the structure, will have wooden ties laid in ballast, the track being left open on the section where the tracks are separated from the roadway and paved with stone blocks where the tracks are in the center of the roadway. The total length of steel superstructure, made up of plate-girder spans over railway tracks, the bridge over the South Platte River, etc., is 1,121 ft. This steel superstructure has a concrete decking, and for the sake of appearance, as well as for the protection which may be afforded, this steel work was incased in concrete, giving it the appearance of a concrete structure throughout.

Methods of Construction Used

Work on construction is now proceeding under two contracts. On one of these on which the spans are of uniform length the contractors (the C. S. Lambie Co. and the C. P. Allen General Contracting Co., jointly) are using steel forms for the girders. On the other section, where the length of the span is subject to considerable variation on account of streets, etc., the contractor (the Denver & Pueblo Construction Co.) is building wooden forms entirely. In each case the reinforced-concrete columns are cast first, and after the concrete of these columns has set, the remainder of the superstructure of a tower is poured, including the girders, cantilevers, floor slabs, etc.—if possible, in one operation.

In order to keep the reinforcing bars off the bottom of molds, square steel washers are strung on the lower bars at intervals. The inspector who passes on the reinforcement after it is placed in the forms and before the concrete is poured can see at a glance whether sufficient washers are in place to keep the reinforcement well off the bottom of the form. A separate contract will be let later for building in place the coping and hand railing on the superstructure and laying the concrete curbing and concrete sidewalk. It is noteworthy that all these parts are separate from the superstructure proper, so they can be renewed in case of necessity without affecting the superstructure itself.

Quality of Concrete Carefully Watched

Great pains is being taken in the construction to secure the densest possible mixture of concrete with a view not merely to strength and reliability, but to longevity. Regular analyses are made of the sand used and of the gravel, the results of the analyses are plotted, and with the aid of this diagram the mixture is studied to determine the proportion in the mixture of sand and gravel that will give the minimum percentage of voids.

Besides the regular testing of briquettes and soundness pats from the cement as delivered, enough concrete is taken from every tower poured to make up a set of test cylinders 4 in. in diameter. These cylinders are crushed when 30 days old. No large testing machine on which to crush these cylinders was available within a reasonable distance, so arrangements were made for crushing them in a hydraulic press in a near-by machine shop. The press was carefully calibrated by comparison with a compression-testing machine at the University of Colorado at Boulder, so that the results it gives are deemed reliable.

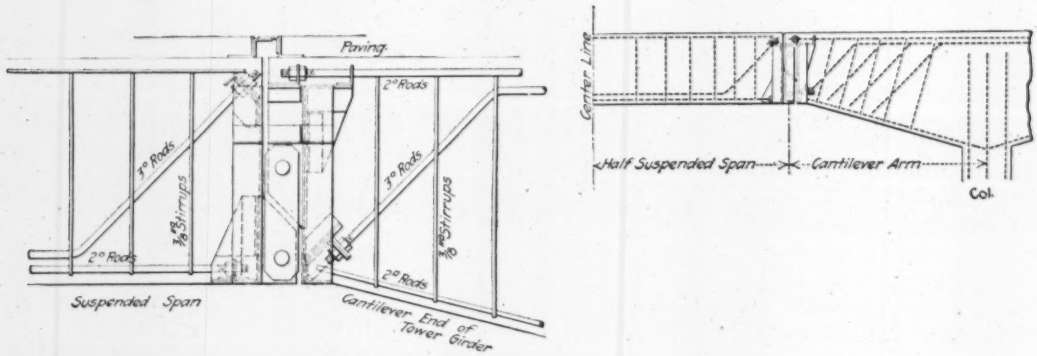

FIG. 6. DETAILS OF REINFORCING STEEL AT JUNCTION OF CANTILEVER AND SUSPENDED SPAN

In order to produce a uniform appearance of the finished surface, the concrete, as it is placed in the forms, is spaded to keep the stone back from the face. After

the forms are removed those parts of the structure where uniform appearance and color are most important are rubbed with carborundum bricks to remove form marks.

The viaduct is being built and paid for jointly by the City of Denver, the three railway companies whose tracks are crossed, and the Denver Tramway Co., which will run its cars over the viaduct. Herbert S. Crocker is the chief engineer of the work. The structure has been designed in Mr. Crocker's office under the supervision of Ira O. Thorley. The steelwork in connection with the erection is in charge of John W. Cerny. At the present time the structure is about three-fourths completed. It is expected that the balance of the superstructure will be

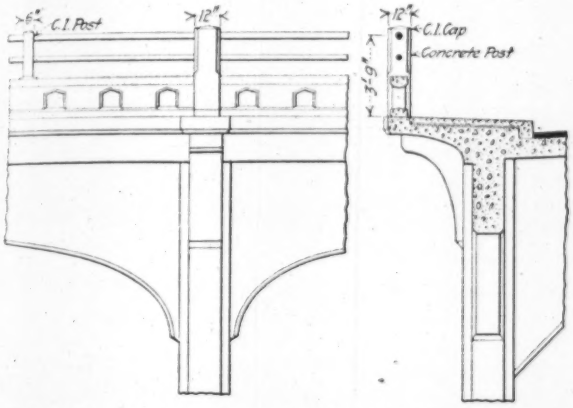

FIG. 7. TYPICAL ELEVATIONS, SHOWING PARAPET AND RAILINGS, COLFAX-LARIMER VIADUCT

erected in the spring and that parapets, hand railing, sidewalks, street-railway tracks, etc., will be placed so that the entire structure will be ready for traffic in the fall of 1916.

Dangers of Public-Utility Commission Control*

By Leonard Metcalf†

The dangers of commission control are most often traceable to the bringing of political or corporate pressure to bear upon individuals where judicial considerations alone should govern. Another danger is lack of experience in the construction and operation of public utilities on the part of the commissioners, and more particularly on the part of some of the engineering staffs appointed by them. Commissions have been seriously hampered through lack of appropriations to command the services of men of mature judgment and breadth of experience. As a consequence valuations have been costly and litigation has followed.

Obviously control implies a certain amount of dictation. If our commissions are to dictate policies, they will require greater opportunity, better facilities and far greater financial support than they now possess, to form and exercise sound, far-sighted judgment. If they then dictate the policies to be pursued in management of the public utilities, the corporations should be relieved of the hazard incident to the enforcement of these policies. If on the other hand the corporations are still to be made to bear all responsibility and hazard, they should be given reasonable latitude in determining policies and the demands of future service and should be accorded rates of return commensurate with the hazards of their business.

Failure to place adequate value upon public-utility properties and the reduction of rates to a point which will not produce a return fair to the owners are dangers to the public which it little realizes. If the difference in value between "the bare bones of the property" and the living going concern is not fully recognized, if spare machinery, reserve structures and reserve properties held for the service of the public or bought for use in the reasonably near future are excluded from the rating base, or if the rate of return fails to provide reasonable depreciation allowance as well as fair return commensurate with actual hazard, the inevitable cycle will follow: (1) Declining service, resulting from failure to keep the property up. (2) Inadequate service, growing out of service standards necessarily lowered for want of proper return. (3) Inability to borrow new capital upon advantageous terms and still more aggravated operating difficulties.

The writer is conscious that in the foregoing illustrations he has perhaps overemphasized the dangers to the corporation, as compared to the benefits to the public, to be attained by competent regulation of utilities by public-service commissions. This somewhat unbalanced presentation has followed in part as a result of some recent experiences, and in part because the direct advantage to the public of the commissions' powers to curb the corporations is more evident. This latter function is so prominent that many people have a tendency to lose sight of the judicial or impartial stand which commissions should take, and to think of them mainly, if not solely, as agencies for reducing rates.

The true function of a public-service commission is to act as a referee, charged with seeing on the one hand that the public has to pay no more than a fair price for the service rendered and that it receive service of the character for which it pays, and also with seeing on the other hand that the utilities receive fair treatment and compensation. The public, and the corporations as well, can derive benefit only from the regulation of utilities by an able and impartial commission.

This is equally a fact whether the utilities be owned by corporations or by the public itself. The writer would not be surprised to see the jurisdiction of the commissions more generally extended in the near future to cover matters relating to the accounting, financing, and making of rates of municipally owned utilities.

*From the presidential address to the New England Water-Works Association, Jan. 12, 1916. Some of the advantages of utility-commission control were briefly stated in the address.

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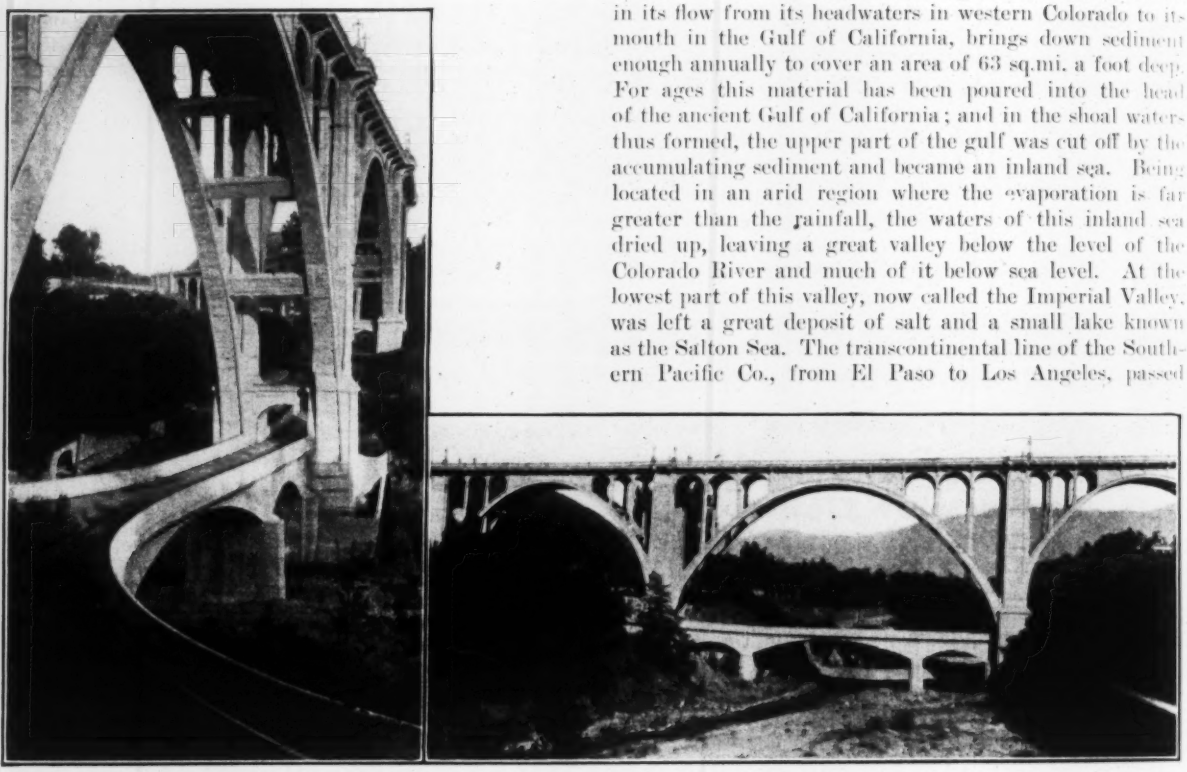
The Merchant Marine of the United States, according to the annual report of Commissioner of Navigation Eugene T. Chamberlin, not only exceeds that of any other nation of the world, except Great Britain, but its total tonnage equals that under any other two foreign flags combined, except Great Britain. It is true that a great bulk of our merchant marine is engaged in the coasting or domestic trade, the lake shipping accounting for a large part of the total. It is also true however, that owing to the operation of the ship-registry law, enacted Aug. 18, 1914, there has been a great increase in ocean vessels under the American flag, and it is stated that nine-tenths of the vessels which have been transferred from foreign flags to American flags under that law were owned by Americans previous to the transfer. The number of ocean merchant steamers of over 3,000 gross tons under different flags on June 30, 1915, was as follows: British, 3,063; German, 544; American, 315; French, 228; Japanese, 225; Italian, 211; Dutch, 189; Norwegian, 116.

Valley Crossing Requires Low-Level Bridge

The requirements of low-level traffic across the Arroyo Seco, at Pasadena, Calif., have led to the construction of a second bridge across that stream—or rather stream bed—underneath the massive Colorado St. bridge, which was completed about two years ago. (See description in *Engineering News*, July 24, 1913, p. 146.)

The high bridge, one of the finest concrete structures in the West, is 1,470 ft. long, made up of 15 arches varying in span from 30 to 223 ft. It spans a deep valley about 1,500 ft. wide and 175 ft. deep. Even before the bridge was built, there was considerable travel across this arroyo by means of several circuitous crossroads having very steep grades at each side of the valley. A small truss bridge spanned the actual bed of the stream. Some time ago, after the larger structure was finished, the small bridge was washed out and practically destroyed. This bridge was used constantly by the ranchers living in the bed of the arroyo. After its destruction it was soon found that something would have to be provided to take its place. A reinforced-concrete bridge was decided upon, to be located directly within the larger structure so that the piers of the large viaduct might be utilized.

This small bridge is 220 ft. long, 20 ft. wide and 50 ft. above the bed of the stream. The bridge has a central span of 130 ft. and two flanking 37-ft. spans. The small piers, like the piers of the larger bridge, rest upon rock. Fortunately, the piers of the high bridge were designed with twin shafts beginning a short distance above ground, so the roadway lower bridge passes through the openings.



A LOW-LEVEL BRIDGE UNDER THE ARROYO SECO BRIDGE AT PASADENA

Solving the Imperial Valley Irrigation Problems

After a dozen years of physical and financial difficulties, the irrigation and allied industrial problems of the Imperial Valley seem to be solved, except as regards further protection against the overflow of the Colorado River and the complications due to the fact that a large part of the main irrigation canal is on Mexican soil. The solution has been brought about by (1) a settlement between the company owning the irrigation works, its railway backers and the owners of the salt works which were wrecked when the floods of the Colorado were let into the Imperial Valley by a temporary irrigation heading cut through the bank of the Colorado, and (2) an agreement by which the irrigation works will be transferred to the Imperial Irrigation District, recently organized under the California irrigation-district law.

The Colorado River, descending more than 5,000 ft. in its flow from its headwaters in western Colorado to its mouth in the Gulf of California, brings down sediment enough annually to cover an area of 63 sq.mi. a foot deep. For ages this material has been poured into the head of the ancient Gulf of California; and in the shoal waters thus formed, the upper part of the gulf was cut off by the accumulating sediment and became an inland sea. Being located in an arid region where the evaporation is far greater than the rainfall, the waters of this inland sea dried up, leaving a great valley below the level of the Colorado River and much of it below sea level. At the lowest part of this valley, now called the Imperial Valley, was left a great deposit of salt and a small lake known as the Salton Sea. The transcontinental line of the Southern Pacific Co., from El Paso to Los Angeles, passed through this depression close to the Salton Sea, and a company known as the New Liverpool Salt Co. engaged in the gathering and sale of the salt from the deposit.

Irrigating the Imperial Valley

The California Development Co. was organized to divert water for irrigation in the Imperial Valley from the Colorado River at a point about a mile north of the international boundary line. This water was carried for some 60 mi. in a canal through Mexican territory, irrigating considerable land in Mexico, and then across the international boundary, where it is distributed by a network of canals supplying some 400,000 acres of land in California and a population of over 20,000 people.

As the Mexican law does not permit a foreign corporation to own real estate in Mexico, a separate Mexican corporation was organized to own the portions of the system in Mexico, the stock of this company being owned by the California Development Co. The main canals of the California Development Co. deliver water to the canals of eight or nine mutual distribution companies, known as Imperial Water Co. No. 1, No. 2, etc. These mutual companies own and maintain their own water-distribution systems in the Imperial Valley and pay the California Development Co. by the acre-foot for the water delivered.

At the point where the Colorado crosses the international boundary line the river is about 100 ft. above sea level, and the distance along its channel to the Gulf of California is about 120 mi. The distance from the same point to Salton Sea is also about 120 mi., but as the bottom of the Salton Sea is about 200 ft. below sea level, the slope is two and one-half times as steep.

As readers of *Engineering News* will recall, in 1904, through careless handling of the intake where the California Development Co. diverted water from the Colorado River, the whole flow of the river was diverted toward the Salton Sea. In its course the torrent eroded millions of cubic yards of earth. It flooded the salt lands owned by the New Liverpool Salt Co., destroyed its mill and vats, flooded the tracks of the Southern Pacific Co. and cut back a deep gorge which, if it had been permitted to continue, would have in a short time reached the junction with the old channel of the river and made forever impossible the restoration of the river to its former course.

While the California Development Co. was legally responsible for this catastrophe, it was at the time in financial difficulties and was wholly impotent to take the necessary measures to stop the breach. In this emergency the Southern Pacific Co., at the urgent solicitation of President Roosevelt, closed the break in the river bank under great difficulties. The work was undertaken by the railway company under promise of President Roosevelt that Congress would reimburse the company for the expenditure it had incurred. But notwithstanding the circumstances under which the work was done and the enormous benefit to the country of averting the impending catastrophe, Congress has never appropriated a cent to pay for this work.

Suits for Damages Caused by the Flood

After the break was closed, the New Liverpool Salt Co. sued the California Development Co. to recover the value of its property which had been destroyed by the flood. Judgment was rendered in favor of the salt company on Jan. 10, 1908, for $458,000. Meanwhile the California Development Co. was without funds to carry on further necessary work to secure the Colorado from other dangerous outbreaks, and it borrowed funds from time to time from the Southern Pacific Co. For the various advances which the Southern Pacific Co. made to the California Development Co. and its subsidiary Mexican corporation, it brought suit and secured judgments against the company of about $2,880,000. Besides these judgments against it, the California Development Co. had issued bonds on which it failed to pay interest, and in December, 1909, suit was brought to foreclose the mortgage given to secure these bonds.

After many years of litigation, the Supreme Court of California has recently rendered a decision giving to the bondholders of the company a first lien on all the property of the system, giving the salt company a claim to the California property ahead of the Southern Pacific, and the Southern Pacific a claim to the Mexican property ahead of the claim of the salt company. The court has also ordered that to satisfy these various claims the property shall be sold at public auction to the highest bidder. An agreement has been reached between the Southern Pacific Co. and the salt company under which they will act together, and it is expected that the Southern Pacific Co. will buy the property at the sale.

Meanwhile the Imperial Irrigation District has been formed under the laws of California to own these various canals and connections, and it is expected that it will take over the property after its final sale. An issue of $3,000,000 in bonds of the Imperial Irrigation District has been approved by the state authorities of California, and it is expected that these bonds will be used to satisfy the judgments.

Annexation of Colorado Delta to the United States

With the conclusion of this long drawn out litigation, the matter of the security of the water-supply of the Imperial Valley and the relation of the Federal Government thereto receive new attention. As has been fully pointed out in articles published in *Engineering News* at various times, there has for several years been grave risk either of a new breach, due to the river turning its waters again toward the Salton Sea, or of a diversion of its channel toward the east, which would cut off the flow through the irrigation canals. The War Department has recently asked Congress for an appropriation of $1,250,000 for work on the Volcano Lake levee, which it is believed will protect the points of greatest danger.

A source of constant difficulty encountered by all the engineers who have worked on the Colorado River control has been the complications growing out of international relations. In controlling the flow of the Colorado, promptness is essential. Delay in unraveling the red tape of international complications might easily cause a loss that would be irreparable. The continued safety and very existence of the entire Imperial Valley with 400,000 acres of irrigated lands and a population already numbering over 20,000 are dependent on control of the Colorado. The engineering problem of that control is a difficult one but is possible of solution if the engineer has a free hand; but if the engineer is obliged to stand helpless while customs or other restrictions hinder his work, the river may at any time get the upper hand. This is the reason why sentiment in the Imperial Valley is very strong in favor of annexation to the United States of the remainder of the Colorado delta, or at least of enough of it so that it will not require joint action by both nations to control the flow of the Colorado.

Vessels Under Contract in American Shipyards during the first 11 months of 1915 totaled 761,511 gross tons. They include 98 ocean vessels as follows: 11 collieries, 47 for carrying bulk oil, 34 for general freight and 6 passenger-and-freight ships. Of these, four vessels of 3,500 tons each and two of 5,000 tons each are for foreign owners. The largest ships are 10,900 tons each. These contracts are being handled by 29 shipbuilding companies, of which 14 are located in the East, and three on the Pacific Coast. Most of the remaining companies are located on the Great Lakes.

Field and Office

Combining a Bridge Abutment with a Culvert

By Irving W. Harrison*

A 172-ft. steel bridge over the Naugatuck River at Bank St., Waterbury, Conn., is being replaced by a three-span reinforced-concrete arch structure. The old bridge is of the familiar parabolic truss type extensively built in this part of the country three decades ago. This particular bridge was built about 27 yr. ago by the Berlin Iron Bridge Co. It has a span of 172 ft. 8 in., a skew of 40° and a width of 50 ft. It weighs about 200 tons.

It was first intended to dispose of the old structure to the highest bidder, but it was suggested that the bridge might be used to carry another street, known as Freight St., about a half-mile upstream. There was one difficulty which had to be overcome: Alongside the proposed layout of the street there is a tailrace from a brass works, which discharges into the river just below the bridge site; it was undesirable to have this stream cross the new street, and it was unwise to run it into the river above the bridge, owing to the proximity of a dam just above. The difficulty was solved by carrying the tailrace through the bridge abutment.

The accompanying illustration shows the design and dimensions of the concrete outfall and abutment.

The bridge was taken apart, loaded on trucks and carried to the new site. It was then scraped and given two coats of paint and reërected. No field riveting was done, bolts being used.

The abutments were built by the O'Brien Construction Co., of New York, at a contract price of about $10,000. The bridge was moved and rebuilt by the Spaulding Construction Co., of Suffield, Conn., at a contract price of $9,000. The last-named concern also built a temporary approach trestle on the east end (over the tailrace), at a cost of $1,800.

*Assistant Engineer, City Engineer's Office, Waterbury, Conn.

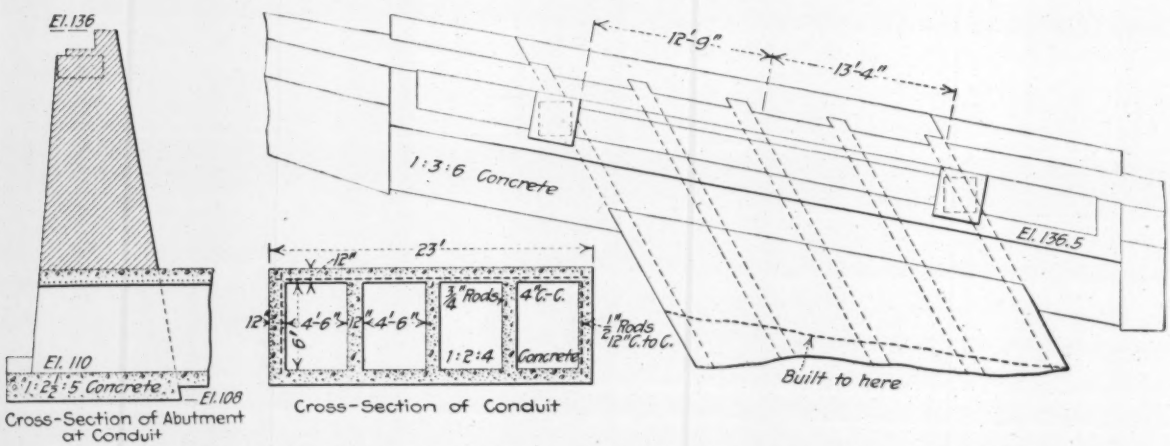
Work on the abutments was commenced in June, and the bridge was finished about the first of November. The work was done under the supervision of R. A. Cairns, City Engineer, and the abutments were designed by Eric Benedict.

Paving a Narrow, Busy Street

A problem in repaving was that of Van Buren St., Chicago, through the congested "loop" district. The street has two car tracks, with space each side for a single line of wagons. After months of piecemeal tearing up of paving, of trenching, backfilling and rough repaving for the various public utilities, the permanent paving was started. One side of the street was taken at a time, for four or five blocks, all traffic in one direction having to use the car track. Plank driveways were placed at some street intersections, and others were closed.

Grading was done with a small revolving steam shovel, although the space was occupied by numerous manholes. This work was done at night, as it was not possible to stop wagons for filling during the day. A small tandem steam roller consolidated the subgrade. Sand and screened gravel were deposited in piles on the subgrade, and men with wheelbarrows charged a steam concrete mixer. The mixer had a drop-bottom bucket on a horizontal boom, but on part of the work the doors did not close tight, so that the grout ran out in a pool on the subgrade while the concrete was being filled into the bucket. Consequently the concrete was rather patchy, rich in some places and relatively dry and lean in others. The surface was not dressed to templet but simply leveled off roughly.

After the necessary time for setting of the concrete, sand was dumped in piles, and dry cement was mixed with it. This mixture was spread and leveled (and generally sprinkled) in advance of the laying of the creosoted wood blocks, which had been stacked along the



BRIDGE ABUTMENT AT WATERBURY, WITH TAILRACE CULVERT THROUGH IT

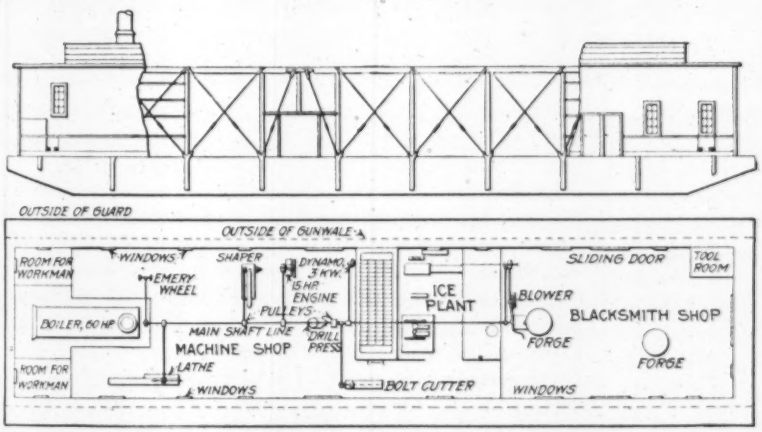
walk and were delivered to the block layers by wheelbarrows.

A tank wagon (with heating furnace and flue) was kept near the work. The hot pitch was delivered in coal buckets and spread over the surface by squeegees. Sand was spread over the pitch, and traffic was allowed upon the paving as soon as the pitch was dry.

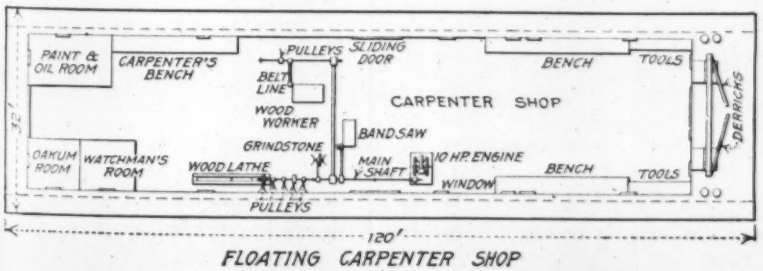
The sand was left on indefinitely, as is the usual practice, although the amount that can be worked into the pitch and blocks by the traffic is limited, and the remainder continues to be ground into dust and blown about the neighborhood. In some cases complaint of this nuisance has led to the removal of excess sand.

Two Shop Boats for Keeping Plant in Repair

A machine-shop boat and a carpenter-shop boat compose part of the equipment employed at Kogers Island on improvement of the lower Tennessee River. These boats, described by Major H. Burgess in *Professional Memoirs* for November-December, 1915, not only keep the plant in repair, but also manufacture small repair parts. The machine-shop boat carries a small ice plant and a blacksmith shop. The equipment at Kogers Island includes two dipper dredges with 1½-yd. buckets, one towboat and one small steam tender, three derrick-boats equipped with 1-yd. orangepeel buckets, two full-sized drill rafts and tenders, one half-sized drill raft and small tender, and a number of scows, barges, quarter-boats, launches and skiffs. Another party is working at Big Bend Shoal, and important repairs upon its equipment are made by the shop boats at Kogers Island. The two forces have been moving farther apart, until at the present time they are separated by 40 mi. or more.



FLOATING MACHINE SHOP



FLOATING CARPENTER SHOP

LAYOUT OF TWO FEDERAL SHOP BOATS—MACHINE AND CARPENTER

The layout of the floating carpenter shop is shown by the lower sketch. A shop building 106x24 ft. in plan by 11 ft. high was constructed on a decked barge and equipped with a wood-worker, a lathe, a bandsaw with adjustable table and a grindstone, all driven by a 10-hp. gasoline engine. There is also an electric borer. At one end are two derricks for handling heavy timbers, small launches and skiffs, one of which is rigged with a double and triple block, the other with a differential chainblock. The derricks place heavy pieces on roller cars, which can be moved readily about the shop.

The floor space is sufficient for simultaneously working on two or three of the longest and largest boats used in the fleet, for building at one time several skiffs or for repairing a launch at the same time that skiffs are being built. When the demand for carpenter work is light, the floor space can be utilized for storage.

The barge cost $4,375 to build and $2,000 to equip with cabin and machines.

The hull of the machine-shop boat is exactly like that of the carpenter-shop boat. Its total cost equipped was about $11,520. The steam for operating engines, pumps and generator set is supplied by a 60-hp. boiler.

SHOP COST AND PURCHASE PRICE OF DREDGE PARTS

Dipper Dredge Parts	Shop Cost	Cost from Dealer
Dipper shaft, weight 50 lb.	$2.25	$5.00
U-bolt, weight 125 lb.	6.50	13.50
Latch keeper, weight 60 lb.	4.75	9.80
Latch bar, weight 36 lb.	2.80	5.94
Bottom band, weight 200 lb.	8.50	13.35
Back brace, weight 108 lb.	4.60	8.69
Door plate, weight 345 lb.	14.60	18.98

The blacksmith shop occupies the full width of the cabin, is 37 ft. long and contains two forges, two anvils, one power blower and the usual equipment of tools, quenching tanks, etc. The floor is covered with a 2-in. carpet of mixed coal dust and cinders, which is kept damp for fire protection. There are three shifts of one man each. Comparatively heavy work can be done here; for example, a broken 5-in. wheel shaft of one of the towboats was successfully welded and the wheel again in service in 48 hr. An important duty of the smiths is to keep ready for use an extra bucket of each size and shape for installation on any dredge or derrick boat.

In the machine shop, power is furnished by a 15-hp. Dayton center-crank vertical engine. The general layout of the shafting is about what is found in a small machine shop on land. The principal work of the mechanics is keeping ready for service the full number of drills needed for one half-sized and four full-sized rafts—that is, about 54 drills. The service of the drills, especially in the flint, is severe, and four or five are broken a day.

The actual cost of making certain dredge parts at the shop and the purchase price from dealers, according to the experience of the past two years, are tabulated above. To the shop cost should be added about 10% to cover depreciation, overhead charges, and other elements of total cost.

Little Scioto Viaduct Founded on Clay, Piles and Rock

By H. B. Watters*

A steel viaduct 1,080 ft. long, on concrete pedestals, is being built over the Little Scioto River and the Portsmouth and California Turnpike, on the Chesapeake & Ohio Northern Ry., near Sciotoville, Ohio. There are two bank piers and 34 pedestals. On top of these will be placed a steel structure with 40- and 80-ft. spans.

The first four pedestals and the abutments on the south end were founded on a compact clay with bases spread sufficiently so that the bearing is less than 2 tons per sq.ft. The next eight pedestals rest on piles driven 15 ft. to rock, as it was not considered safe to build on the soil encountered, which was a very wet brown clay. Under each pedestal 16 piles were driven to standstill, on about 3-ft. centers. The next eight pedestals were founded on rock, this precaution being taken because they were in or near the river proper. They go into the rock from 1 to 4 ft. Four of these pedestals (or two bents) come in the river, and a cofferdam 24x64 ft. in plan was built to take in one of these bents (or two pedestals). A single row of 15/8-in. sheetpiles was driven outside 10x12-in. timbers spaced about 4 ft. c. to c. The water was about 14 ft. deep at its maximum, and one pump with a 3-in. discharge easily kept out all the water. The pump was not taxed to capacity at any time. The other four pedestals were put down in the same manner with a 17x17-ft. cofferdam inclosing them.

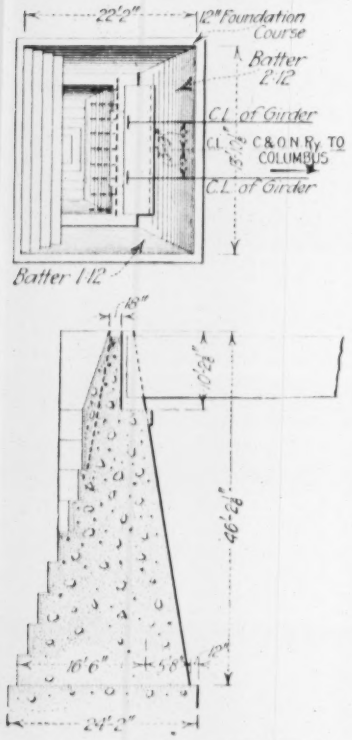


FIG. 2. DETAILS OF SOUTH ABUTMENT

The next four pedestals are on 24-ft. piles driven to rock, the next four on 15-ft. piles to rock, and the last are set directly on rock. No serious difficulties were encountered. High water stopped work for only a few days.

In the foundations carried on piles a band of 1/2-in. twisted steel was placed near the tops of the piles, inside which the vertical reinforcing rods (which run up each of the four corners of a pedestal) were placed and wired together. These bands occurred every 2 ft. to the top of the pedestal.

*Resident Engineer, Chesapeake & Ohio Northern Ry., Sciotoville, Ohio.

Rescuing a Dredge Frozen Up in the Mohawk River

By A. E. Steere*

One of the difficulties encountered by contractors along the Mohawk River, New York, in excavating for the new Barge Canal, has been the inability to forecast correctly the ice conditions a sufficient time in advance to enable the various dredges to reach harbors of safety before being frozen up. The contract for dredging in the Mohawk River between Rexford Flats and Yosts, a distance of 36.2 mi., is held by the American Pipe and Construction Co. and comprises prism excavation in the various pools formed by one fixed dam and five dams with movable crests. In the case of the dams with movable crests, it is imperative that the dredging plant be moved to winter quarters before ice forms to such a thickness as to render the raising of the dams unnecessarily hazardous.

In the first week in December the contractors had plant working in each of the six pools formed by the dams. During the following week the weather turned cold, and on Dec. 10, dredging operations stopped. The dredges were dismantled in order that they might pass under the railroad and highway bridges on their way to winter quarters. The different dredging fleets belonging to the company were successful in reaching harbor, with the exception of the hydraulic dredge "Amsterdam," which was frozen in the ice 3½ mi. above the movable dam at Scotia. It was imperative that a strenuous effort be made to float the dredge into the lock at Scotia and thus permit raising the movable crest there. One mile of the distance had been covered by Dec. 13, when a heavy snowstorm was encountered. By the following morning the snow was 18 in. deep. The weight of the snow caused the ice to sink so that the snow became slush, subsequently freezing and rendering it extremely difficult

*Resident Engineer, Mohawk River District, New York Barge Canal, 3 Mark Building, Amsterdam, N. Y.

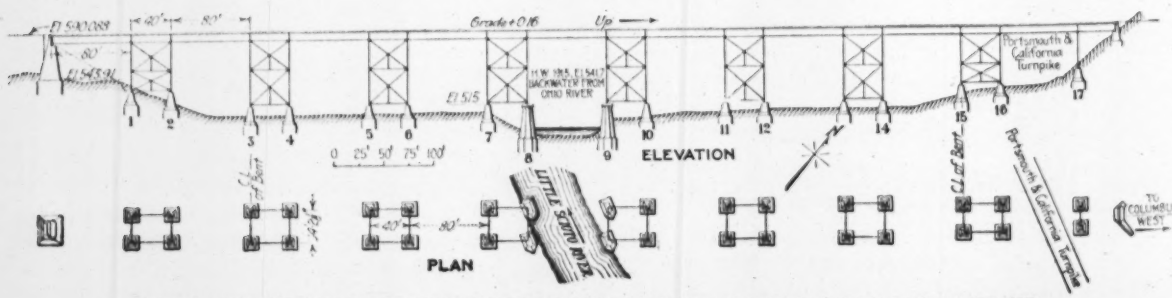


FIG. 1. ELEVATION OF LITTLE SCIOTO RIVER VIADUCT, WITH PLAN OF FOUNDATIONS

to deliver coal to the dredge and meals to the crew. This condition was overcome later in the day, and some progress was made.

The method pursued in forcing the dredge through the ice field was anchoring the steel cables from the winding engine to deadmen and trees along the river banks, breaking the ice immediately in front of the hull by raising and lowering the cutter ladder and taking a heavy pull with the winding engine. This method worked satisfactorily until the dredge was within a mile of the dam, when ice 6 in. thick was encountered.

The remainder of the channel was blasted in sections ranging from 150 to 200 ft. in length. The method pursued in blasting the ice was to suspend 3-lb. charges of dynamite in rows 10 ft. c. to c. and 3 ft. under the ice. The shots were fired by electric current from the generator on board. In this manner the dredge was pulled ahead until it reached the lock, on Dec. 18.

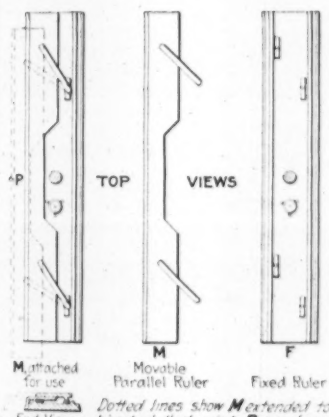
The ice immediately above the dam was cleared away by blasting and the gates and uprights were raised from the river, thus concluding the operation.

A force of 60 men was engaged in rescuing the dredge. The superintendent, chief engineer and leverman remained on board throughout the week, sleeping on and around the main engine. The American Pipe and Construction Co. is the contractor; H. W. DeGraff, General Superintendent, and W. J. Judge, assistant, were in immediate charge of the dredge.

Parallel-Ruler Alidade for the Plane-Table

By C. T. Bussell*

During the season of 1915, while engaged on a plane-table survey of the coast line of Prince William Sound in Alaska, the following described alidade attachment suggested itself as a means of greatly facilitating plane-table surveying. A description of this device was sent to E. Lester Jones, Superintendent, United States Coast and Geodetic Survey, and it has been now made a part of the standard alidade of the service. This alidade attachment is essentially a parallel ruler such as is used in navigation and in drafting. It can be fastened to either side of the alidade and is so connected that it readily moves in or out parallel to the fiducial edge of the alidade rule. The object of the device is to save the time of the more or less cumbersome and tedious operations in taking stadia shots with the ordinary plane-table alidade—the adjustment and readjustment of the edge of the alidade ruler so that it will pass through the plane-table station at the same time that the alidade telescope is centered on the object or rod to be located.



PARALLEL-RULER ATTACHMENT FOR PLANE-TABLE ALIDADE

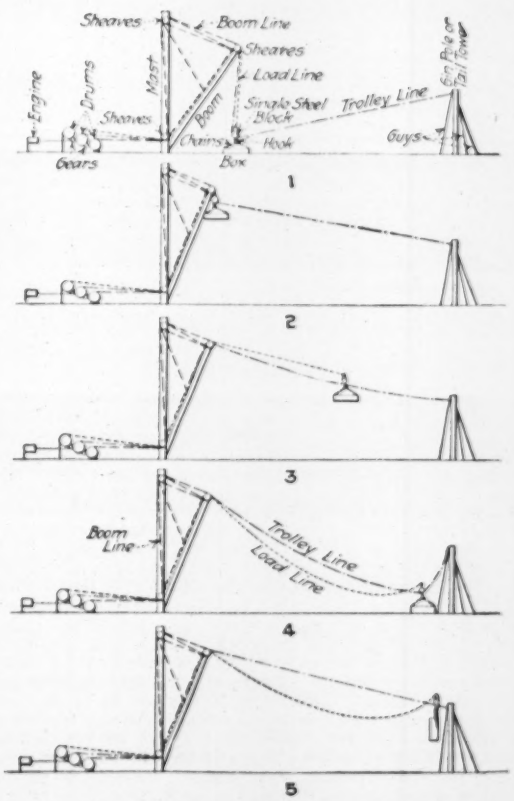
In practice the movable parallel ruler *M* (see illustrations), which is easily and quickly interchangeable from one side to the other without loosening screws or catches, is closed against the fixed edge *F* of the alidade rule. The alidade is then pointed approximately and is so placed on the plane-table sheet that the plotted position of the point *P*, occupied by the plane-table, will remain within the extension limit of the parallel ruler *M* when the alidade telescope is centered on the rod or object sighted at. After the rod reading is taken, the parallel ruler *M* is swung out to bisect the point *P*. The distance or direction line of the object it is desired to locate is then marked off along the edge of *M*.

It is believed that the alidade attachment described will transform an awkward and more or less approximate operation into a smooth mechanical movement with a considerable gain of time. Owing to the ease with which the operation can be performed with this attachment, it is believed also that both the general efficiency and the accuracy of plane-table surveying will be increased.

*United States Coast and Geodetic Survey, Washington, D. C.

Depositing Spoil with Derrick Beyond Reach of Boom

In digging the lock pit for the Sabine-Neches guard lock in Texas, caving banks necessitated considerably more excavation than had been expected, according to M. A. Milliff, superintendent, in the November-December, 1915, issue of *Professional Memoirs*. The dumping area



PROGRESSIVE OPERATIONS OF DERRICK-TROLLEY IN LIFTING AND TRANSPORTING SKIP TO DUMP

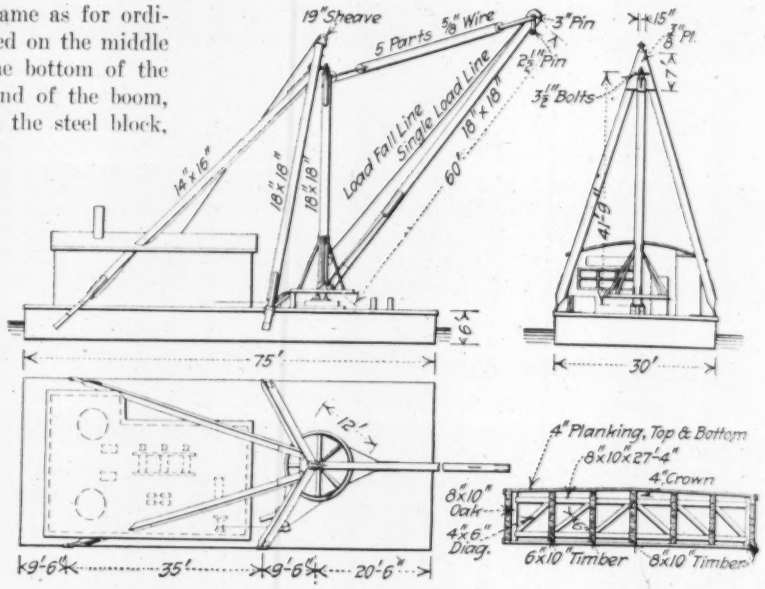
proved insufficient, and the weight of the deposited material caused further sliding of the banks. As the amount of material to be excavated was not sufficient to justify the purchase and erection of a cableway or additional derricks, the derrick on the job was rigged with a trolley line, as illustrated in the sketches.

The rigging of the load line is the same as for ordinary hoisting. The trolley line is carried on the middle drum and runs through a sheave in the bottom of the mast, thence through a sheave in the end of the boom, then around the bottom of a sheave in the steel block, and the end of the line is made fast to the top of a ginpole. The boom line is carried on the front drum, and is rigged the same as for ordinary derrick work. All lines are of 5/8-in. wire rope.

The material box is a 1-yd. open-end skip. The ginpole, or tail tower, 26 ft. high, is of yellow-pine piles, old hoisting rope being used for guys.

This trolley-line arrangement has been operated for a distance of 300 ft. with a 12-ft. drop. Experience shows that a load of at least 2,500 lb. is necessary to operate the trolley on this flat slope. In very soft, wet ground, with a gang consisting of a foreman and five men filling the skips, a foreman, a hoisting engineer, and a laborer to dump the boxes, 137 skips were moved in 8 hr. In harder digging, where it was necessary to load the skips with shovels instead of by bailing, 70 skips were averaged in the same period.

of the new pumping plant there is illustrated by the drawi... At Cherry St. the derrick—rated at 20 tons—handled ... cylinder shells of the foundation, erected the three-hin... arch trusses of the centering and pulled steel sheetpili... The equipment consists of a 3-drum 3-spool 10x12-in. 55-... American engine having eight levers banked, two boilers ... 30 and 40 hp. respectively, swinging gear and a Canton pu...

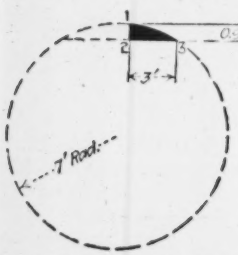


DESIGN OF 20-TON DERRICK BOAT USED SUCCESSFULLY ON THREE CONTRACTS IN TOLEDO

The derrick boat was owned first by C. H. Fath & Sons, who sold it to the National Foundation and Engineering Co., which completed the Cherry St. bridge. It was used by M. F. Comer on the foundations of the high-pressure plant.

NOTES

A Problem for Skillful Calculators—Prof. Harry Gwinner, Maryland Agricultural College (College Park, Md.), puts an interesting practical problem: Find the volume of the part segment of a sphere whose radius is 7 ft., when the altitude of the segment (along one cut face) is 0.963 ft. and the length of the segment (along the other cut face or base) is 3 ft. Any method of solution is acceptable, whether an exact calculus method or an approximate method, graphical or analytical.

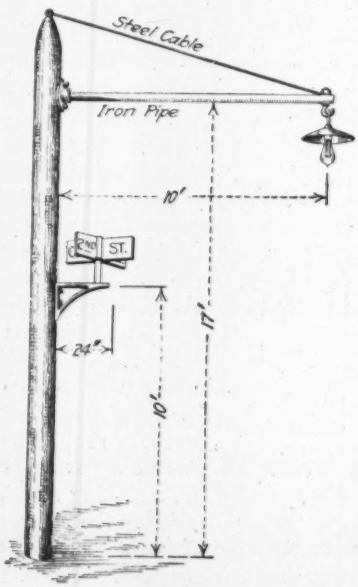


FIND VOLUME OF SPHERICAL PART SEGMENT

A Long-Span Highway Bridge in Washington—A steel bridge with 380-ft. simple truss span, recently built over the Nooksack River in Whatcom County, Washington, to replace a 220-ft. span, is now the longest steel span in the Northwest. The trusses are of the Baltimore type, 60 ft. center depth, this unusual depth being adopted in view of the heavy loading. The bridge has plank floor at present, but it is intended to have a wood-block pavement later on. The structure is figured for very heavy wind load. The piers are of the Fowler type, consisting of pedestals connected by a diaphragm, all of concrete. The pedestals are 14 ft. square at the base and 8 ft. in diameter at the top. They are supported on piles driven to practical refusal. The deck of the bridge is carried by 12-in. I-beams to which are bolted backing strips treated with hot carbolineum. The bridge cost about $32,000, including over 1,000 ft. of approach. It was built for the county, C. M. Adams, County Engineer, C. E. Fowler, Consulting Engineer, by the Weymouth Construction Co., of Seattle.

A Floating Derrick used in the construction of the Cherry and Ash St. bridges, in Toledo, Ohio, and on the foundation

Protect Bridge Flooring by Snow—In an advisory circular issued recently by the Minnesota State Highway Commission, local bridge authorities in the state were counseled to haul snow onto bridges having wooden floors, in order to protect the floor: "On about 80% of the bridges the floors are of wood, which need a protecting mat of snow to keep the sharp-shod horses from wearing out the planks. Snow should be hauled on the bridge to replace that which blows off. This will protect the flooring and make hauling easier for sleighs." The letter also refers to the contraction of bridges with cold and recommends that the roller or other expansion bearing should be examined to see that it is in good working condition.



FOUR-WAY STREET SIGNS VISIBLE BY NIGHT OR DAY

Street Names Always Visible—Street names at intersections are by no means always distinguishable at night. Sometimes one of the names can be read without difficulty, sometimes neither without walking about until the light falls on the signs. In Muscatine, Iowa, City Engineer Young has had the four-way name boards mounted on a metal bracket, which is attached by lag-screws to the wooden electric-light poles, as shown by the sketch. Mr. Young does not claim to have devised this method, which has been used by another city to his knowledge, but he has no hesitation in asserting its success.

American Society of Civil Engineers' Meeting

Once more the annual meeting of the American Society of Civil Engineers, held this year on Jan. 19-21, taxed the capacity of the society's house on 57th St. in New York City. More than 700 members were registered in attendance, but many more must have been in the building at the one business session. In addition to this session there were the usual smoker on one evening and the reception and dance on another evening and inspection visits to the Lexington Ave. subway, the 46th St. piers on the North River and the Kensico Dam of the Catskill aqueduct.

The routine business of the session was marked by only two discussions—one on the advisability of increasing the membership of the committee which bears the rather unwieldy name of "Special Committee on Materials for Road Construction and on Standards for Their Test and Use," and the other, comment by the representative of the Carnegie Foundation on some investigations that that institution has been carrying on in regard to engineering education.

According to the report of the Board of Direction, the American Society of Civil Engineers is in its customary flourishing condition. At the end of 1915 there were enrolled 7,909 members of all classes, but the secretary announced that the admissions since the first of the year—that is, in the first three weeks in January—brought the total number up to the 8,000 mark. This increase, however, is not quite so great as the annual increase in the past few years. In finances the society would appear to be equally flourishing, inasmuch as its general balance sheet shows paper assets of $666,000 and that the regular $10,000 was paid off during the past year toward the mortgage on the society house. Nevertheless, the directors of the society seem to be somewhat cautious, according to the statement of Director Williams, who, in discussing one of the committee reports, said that the expenses of some of the special committees had proved so great during the last year that the board was considering recommending, or had recommended, a reduction of the work of the committees. This remark hardly met with the approval of the members present, and several took occasion to urge upon the Board of Direction the desirability of increasing committee work without regard to expense, if the ends were justified.

Prize Awards and Officers

The following prize awards were made: The Norman medal to Allen Hazen, New York City, for the paper entitled "Storage To Be Provided in Impounding Reservoirs for Municipal Water Supply"; the J. James R. Croes medal to Richard R. Lyman, Salt Lake City, Utah, for the paper on "Management of the Flow of Stream by Approved Forms of Weirs," etc.; the Thomas Fitch Rowland prize to Charles W. Staniford, New York City, for the paper entitled "Modern Pier Construction in New York Harbor"; the James Laurie prize to J. E. Greiner, Baltimore, Md., for the paper on "Coal Piers on the Atlantic Seaboard"; the Collingwood prize for Juniors to George Schobinger, Las Cruces, N. M., for the paper on "The Colorado River Siphon." Mr. Schobinger has since become an Associate Member of the Society.

The officers elected for the ensuing year are: President, E. L. Corthell, New York City; Vice-Presidents, Alfred Craven, New York City, and Palmer C. Ricketts, Troy, N. Y.; Treasurer, Lincoln Bush, New York City; Directors, V. G. Bogue, New York City; Alexander C. Humphreys, New York City; O. F. Clapp, Providence, R. I.; R. Khuen, Pittsburgh, Penn.; F. G. Jonah, St. Louis, Mo., and E. Duryea, Jr., San Francisco, Calif.

It was announced that the next annual convention will be held the last part of June in Pittsburgh, Penn.

Reports of Special Committees

All the special committees made reports, though most of them were to indicate progress only. The Committee on Concrete and Reinforced Concrete reported that it has in preparation a final report which it is expected will be presented to the society before the next convention, next June. The Committee on Steel Columns and Struts presented a report which had been printed for distribution before the meeting. An abstract of it appears on another page of this issue. The Committee on Valuation of Public Utilities reported that it was working hard on the report which takes up in detail all of the various features of valuation work, and that it had already completed a number of the earlier chapters. The report apparently will be quite voluminous and will cover the subject of valuation in a very complete manner. The Committee on Conditions of Employment had only progress to report. The Committee on Soils for Foundations presented a lengthy report, which was not read at the meeting. The Committee on Stresses on Railroad Tracks reported progress. The Committee on Flood and Flood Prevention presented a printed report which took up the many questions covered by its subject. The report starts with a general survey of the flood situation, describes suggested methods for improving the rivers and preventing floods, and makes definite conclusions as to the value of these various methods. A minority report was submitted by Morris Knowles, a member of the committee. The Committee on a National Water Law submitted a report suggesting that the discussion on the principles of water law should be made more general before any definite national water law be promulgated.

Road Committee Report

The Special Committee on Materials for Road Construction, etc., presented a seven-page printed report, which included a semifinal report on nonbituminous materials and an appendix made up mostly of blanks to be used in making tests and reporting data to the committee. Only during the last year has this committee had the nonbituminous part of its title, and it was its intention to report only on that subject at this year's meeting. In the discussion of the committee's report, Eugene W. Stern, Chief of Bureau of Highways, Borough of Manhattan, New York City, presented a motion recommending to the Board of Direction that the committee be enlarged to fifteen, its membership now being seven. As an amendment to this motion, Leonard Metcalf, Boston, Mass., added the recommendation that the committee's scope be enlarged to cover all road work. After a somewhat

acrimonious discussion between several members of the society and the chairman of the committee—in which the members seemed to contend that the road committee had limited its activities and had not presented as complete a discussion of the road question as should be expected after the number of years it had been at work, and in answer to which the chairman stated that the committee's activities were definitely limited by its title—the amended motion was adopted by the meeting. A report of the meeting devoted to highway discussion follows this report.

Engineering Education Investigated

The Committee on Engineering Education reported that it had an investigation in progress, but that it could do very little until the Carnegie Foundation report now under way was completed. Prof. C. L. Mann, who is acting for the Carnegie Foundation, described some of the work which had already been carried out. Professor Mann said that in answer to a number of questions which had been sent out by the Foundation, 1,500 engineers had replied, stating what to their minds were the basic qualities necessary for a successful engineer. These replies were then collated and tabulated by the Foundation, and the surprising fact was discovered that the answers seemed to show that only 13 points out of 100 should be assigned to technical ability in producing a competent engineer. The 87 points out of the 100 were distributed between character, which had 41%; judgment, which included 17½%; efficiency, which included 14½%, and understanding of men, which included 14%. Professor Mann said that the Foundation was sending out another questionnaire, in which the engineers were given the various subheads, and were requested to weigh them according to their own ideas. When the final results from this investigation are available, it is hoped to put the knowledge thus gained into practical use for the engineering schools. Obviously, an engineering school has to know what is wanted to make an engineer before it can produce a man qualified to meet those wants.

Highway Sessions of American Society of Civil Engineers

Two road-and-pavement sessions were held on Jan. 21 in connection with the annual meeting of the American Society of Civil Engineers. The object was the discussion of the semifinal report of the Special Committee on Materials for Road Construction. W. W. Crosby, chairman of the committee, who presided, stated that there had been criticism relative to the amount of work performed by the committee and that some regarded the report as being general rather than definite; but he called attention to the fact that the name of the committee limited its work to materials and excluded a consideration of construction methods.

The first portion of the discussion was devoted to broken-stone, slag and gravel roadways. P. E. Green, of Chicago, sent in a written discussion in which he claimed that if clay is good as a void filler in a gravel roadway, it is also good in a water-bound broken-stone road; this is in disagreement with the report of the committee. As regards frost troubles he said that if the drainage and maintenance are adequate frost troubles will be few. He believes that gravel as a road material is not properly appreciated by engineers. J. H. MacDonald claimed that clean sand used with limestone dust is a useful void f[illegible] in bituminous macadam, but that sand should never used for this purpose in a water-bound road, becaus[illegible] acts as a wedge. The report recommended, "For wa[illegible] bound roadways of some limestones or of some slag[illegible] will be advisable wherever practicable to use for one-h[illegible] the void filler a noncementitious material such as cl[illegible] sand, with the other half of the finer particles of the [illegible] terial itself."

T. J. McGovern, a contractor of Trenton, N. J., s[illegible] that on a 4-mi. gravel road which he had built in Mer[illegible] County, New Jersey, mud, clay, sand and gravel had be[illegible] used as a binder and with equal success. The road had no[illegible] been rolled, yet portions of it 10 yr. old were in exce[illegible]lent condition. He offered to show the engineers present roads built with and without roller and let them pick out which was which. J. H. MacDonald caused some surprise by inquiring whether the gravel had been spread across the road or longitudinally with the axis of the road, because if thrown transversely the road would ravel; if lengthwise, the road would be bonded. A. N. Johnson recommended that gravel and broken-stone roads be harrowed before rolling, in order to make the material homogeneous and allow thorough compacting.

Cement-Concrete Pavements

K. H. Talbot, of the Universal Portland Cement Co., Pittsburgh, spoke of the proper preparation of the subgrade for concrete pavements. When the subgrade is not of uniform compactness it should be torn up and rolled. Clays can be rolled too much, because moisture is bound to enter, upon which the clay will expand with results injurious to the road. The tendency is to use a too wet mix of concrete (others present supported this view). Expansion joints should be formed at right-angles to the axis of the road. Lack of joints causes cracks; riding of slab on slab can be prevented by proper construction of the road. Reinforcement should be placed not less than 2 in. below the surface of the concrete, so that it will not be exposed in high places to battering by traffic. The chief function of reinforcement should be to hold the top of the crack to narrow limits.

Considerable difference of opinion was expressed on the value or need of expansion joints. P. E. Green is not in favor of them; cracks are bound to occur in the concrete from contraction. Clark R. Vanderbilt stated that the subgrade is responsible for cracks; he believes that expansion joints should not be used. W. M. Kinney, of the Universal Portland Cement Co., said that joints formed at a 70° to 80° angle with the axis of the road are not satisfactory because the corners of the acute angles are certain to break off. He cited an instance in Illinois where this occurred, the joint being at 75°. He does not agree with T. J. McGovern, who expressed the belief that the sand and cement should be mixed together before adding the stone, but on the contrary holds that the coarser material makes the cement and sand mix more thoroughly.

Brick and Slag-Block Pavements

Prevost Hubbard opened the afternoon discussion by inquiring why the committee had not considered a bituminous filler for brick as well as for granite-block pavements. Mr. Crosby, the chairman, stated that the committee proposed ultimately to present a report covering bituminous as well as nonbituminous materials. Mr. McGovern believed that cement makes the best filler.

W. H. Connell, Chief of the Philadelphia Bureau of Highways, called attention to the difficulty of getting a bituminous filler in the joints without smearing it all over the surface. He said that this trouble should be obviated, as a bituminous filler is desirable in certain instances. J. W. Howard and T. J. McGovern favored a cement filler. W. C. Perkins, Chief Engineer of of the Dunn Wire-Cut Lug Brick Co., also favors cement filler, as it makes the pavement monolithic, waterproof and smooth and protects the edges of the brick from chipping under traffic. He suggested that the committee in its next report specify standard paving-brick dimensions. He is in favor of a standard surface 8½x3½ in.; such a brick can be produced by all brick manufacturers. As to shape, he believes that bar lugs and raised letters on bricks are inadvisable and that square edges are better than round, the latter reducing the security of the bond. He does not favor a sand cushion under the bricks; the committee is right in recommending a 1-in. cushion rather than a 2-in., but it would be better still to eliminate the sand cushion entirely, substituting a cement-sand bed laid dry. Baltimore has used the latter (1:5 mixture) during the past year, and Cuyahoga County, Ohio, has used it recently for 50,000 sq.yd. of pavement. He suggested that the depth of brick should be reduced from 4 in. to 3½ in., in order to decrease freight charges.

Mr. Connell wondered if it were not advisable for engineers to specify the composition of brick. The requirements could then be varied to suit traffic conditions on various streets. Mr. Perkins replied that the quality of the brick cannot be foretold from the appearance or quality of the shale.

STONE-BLOCK AND WOOD-BLOCK PAVEMENTS

J. W. Howard recommended that instead of specifying that stone blocks should be composed of medium or fine-grained granite, the following clause be substituted: "Stone blocks should be composed of uniform-grained granite free from laminations." H. W. Durham subscribed to this recommendation. Mr. Durham also commented on the use of sand as a joint filler, a practice which the committee very properly did not recommend. He agreed that sand was no good as a permanent filler, but held that it was permissible in temporary paving. As regards the use of recut stone blocks, which the report said "had been demonstrated to be capable of producing economical and satisfactory results and should be encouraged," Mr. Durham believed that recut blocks could be used in many cases, but not in Manhattan, because of the poor quality of the old stone pavements there and because the heavy traffic would prevent the recutting being done on the job, as economy requires.

Civil Engineers' Society May Move Its Headquarters

At the annual meeting of the American Society of Civil Engineers last week, while no public announcement was made, it became generally known that the Board of Direction had for some time been considering the feasibility of removing the society's headquarters in New York City to the Engineering Societies' Building on 39th St. near 5th Ave., which was erected a dozen years ago, as will be recalled, to constitute a general headquarters for professional engineers in New York City. The building is owned and occupied jointly by the American Society of Mechanical Engineers, American Institute of Mining Engineers and American Institute of Electrical Engineers, known as the three founder societies, and a considerable number of smaller engineering societies, national and local, are tenants in the building. It is understood that the Board of Direction proposes to submit the question to the membership of the society for a vote and will soon send out full information concerning the proposition.

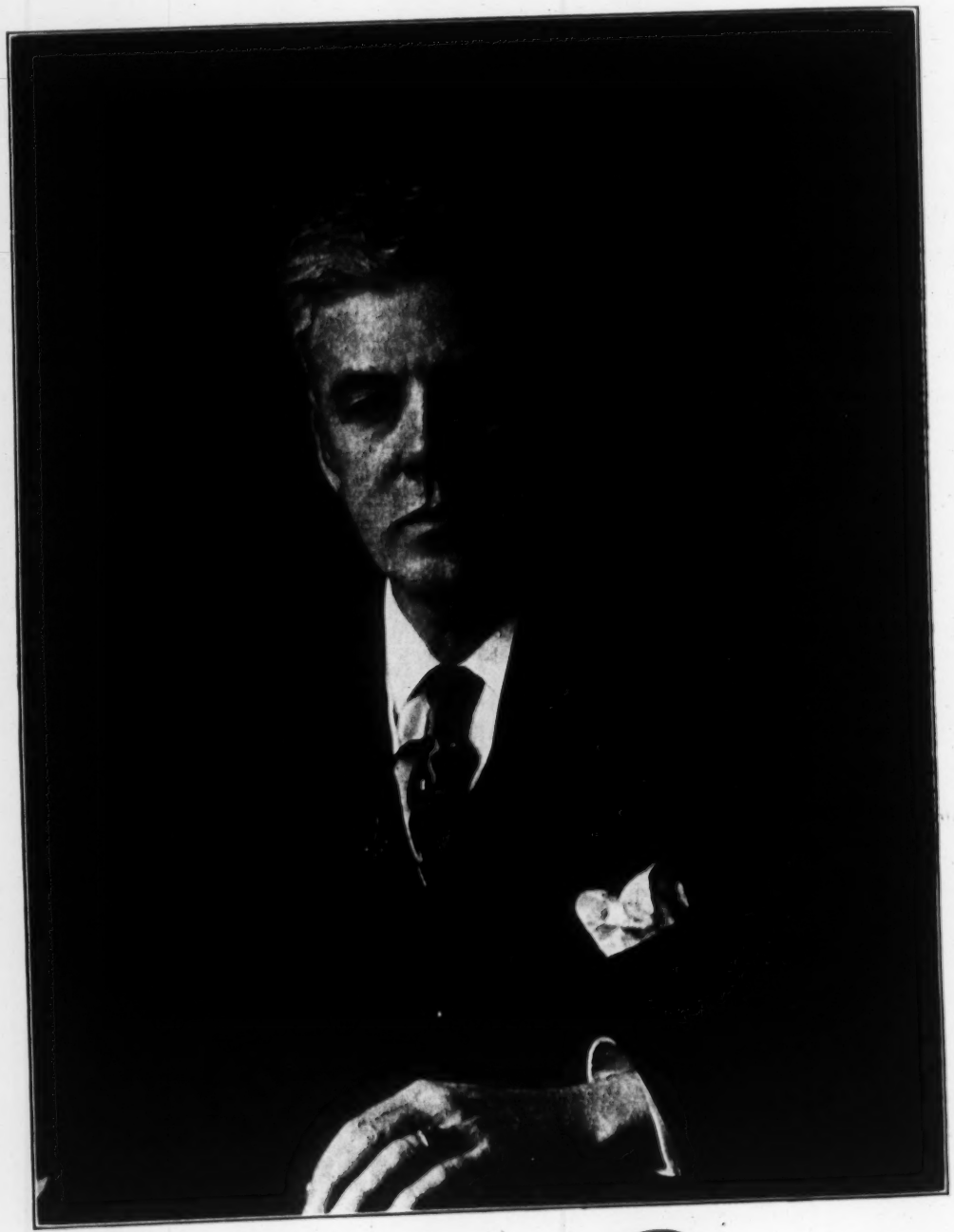
New York Garbage Valuable

The garbage of New York City is growing valuable in the opinion of garbage-disposal contractors. Three years or so ago the city was paying $50,000 a year for getting rid of garbage delivered by it to the waterfront, and that price was lower than what the city formerly paid. On July 31, 1913, the city signed a contract for garbage disposal. The contractor was John J. Hart, of Peekskill, N. Y. He agreed to pay the city $62,500 a year for the garbage delivered to the waterfront during the first year, $87,500 a year the second year and $112,500 the third year. The city then had the option of discontinuing the contract or continuing it two years more at the last-named price.

In order to determine whether to terminate or continue this contract, the city secured new bids on Jan. 18. (See *Engineering News*, Dec. 30, 1915, p. 1290, for conditions.) Under Plan 1 Gaffney, Gahagan & Van Etten, 52 Vanderbilt Ave., New York City, offered to pay the city $120,000 a year for the first year, $150,000 the second year, $180,000 the third year, $210,000 the fourth year and $240,000 the fifth year, or a total of $900,000 in five years for the garbage of Manhattan, the Bronx and Brooklyn, delivered to the waterfront of the city. Under Plan 2 the same bidders offered to erect a plant on a site to be supplied by the city and to operate that plant for five years without payment, with the understanding that at the end of the period the city would take over the plant for $1,500,000. The contractor's estimate of the cost of this plant was $2,500,000. Taking this estimated cost at its face value, the city would receive at the end of five years $1,000,000 for its garbage. This bidder proposed to put up a plant of the Cobwell type, such as is now being operated by a company at New Bedford, Mass., and by another company at Los Angeles, Calif. (See *Engineering News*, Dec. 24, 1914, p. 1249.)

There was one other bid under Plan 1. This was from Milton A. Willmont, of 581 Park Place, Brooklyn, who offered $1 a year for the garbage of each of the five years of the proposed contract.

An injunction against the award of the contract was immediately secured by the New York Sanitary Utilization Co., owners of the garbage-reduction works now in operation at Barren Island, and lessors of these works to the present contractor for disposal. This company was the one that was receiving $50,000 a year for garbage disposal before the present contract went into effect. It bid $130,000 a year for the whole period of five years since the last previous contract expired. The company bringing the injunction suit claims discrimination, since the terms of the call for bids excludes the location of the plant on the Barren Island site.



John R. Freeman

Editorials

John Alexander Hill

John A. Hill, President of the Hill Publishing Co., died suddenly from heart disease on Monday morning, Jan. 24, while traveling in his motor car from his residence in East Orange, N. J., to his place of business. Mr. Hill had been engaged as usual in business affairs and was to all outward appearances in perfect health. Very few, even of his intimate associates, knew of the affection of the heart that resulted in his sudden death.

Mr. Hill was 57 years of age, having been born on Feb. 22, 1858, on a remote hill farm in the town of Sandgate, near Bennington, Vt. His father was a farmer and wheelwright, and the boys of the family, like most boys on a New England farm of that day, were brought up to work from earliest childhood. The family emigrated to southern Wisconsin, settling a few miles west of Madison. John was in charge of a flock of 300 sheep when less than 10 years of age, and in the intervals of farm and other labor attended school for a few months each winter for five years. At 14 years of age he went to work in a country printing office and three years later was its foreman. He had a Yankee boy's liking for machinery, however, and after some years in the printing office he became half owner of a machine repair shop in the village where he lived. In 1878 he went to Colorado and took a job as fireman on the Denver & Rio Grande R.R., but was promoted to the throttle side of the cab within a year. He displayed in his work such mechanical ability, coupled with such keen judgment of human nature, that he became a roundhouse foreman and later assistant superintendent of motive power.

His bent toward journalism and the printing office was shown by his founding in 1885 the *Daily Press*, of Pueblo, Colo., which journal he edited for a year. As a writer he had a forceful and breezy style, and his thorough familiarity with practical matters and with the ideas and needs of the men in the shops and on the road enabled him to write articles which were well received by the technical journals of that day.

A number of these papers were contributed to a modest sheet called *Locomotive Engineering*, which was published in New York by a company that also published the *American Machinist*. In 1888 Mr. Hill was invited to come to New York and take charge of *Locomotive Engineering*. Under his charge the journal rapidly increased in importance. Seeing the possibilities in the enterprise, Mr. Hill associated himself with the veteran Angus Sinclair, purchased the journal from its owners and undertook to carry it on as a separate publication. In this venture Mr. Hill was both editor and publisher, and his genius was well proved by the phenomenal success of the publication. Its subscription list grew by leaps and bounds, and it rapidly assumed the leading position in its field.

It was evident to Mr. Hill's keen business sense, however, that a journal appealing largely to locomotive runners had not the elements for the largest financial success, and he perceived the opportunity of applying modern business and editorial methods to the *American Machinist*, a journal of standing and reputation, which had been conducted for years along ultra-conservative lines. In 1896 Mr. Hill sold his interest in *Locomotive Engineering* to his partner, Mr. Sinclair, purchased the *American Machinist* and laid the foundation for one of the largest enterprises in the field of technical publication.

At that time practically all class publications had their printing done by contract and were limited by such facilities as the printers were willing to provide. Mr. Hill's early experience in the printing business had given him a strong liking for this side of the publisher's work, and he was ambitious that his publication should be able to own and operate its own printing plant. In order that such a printing plant shall be commercially successful, however, it cannot concentrate its work upon a single journal, but must be able to distribute it over a number.

It was this situation among others which led Mr. Hill to add to the successful *American Machinist* other well-established technical journals of high reputation. His first purchase, in 1902, was *Power*. Later, following the death of Richard P. Rothwell, founder of the *Engineering and Mining Journal*, that publication passed under Mr. Hill's control. In 1911 he purchased the *Engineering News* from its founder and chief owner, George H. Frost.

To carry on these various publications Mr. Hill organized the Hill Publishing Co., in which, while he held the largest interest, a number of those associated in the conduct of the various journals were also stockholders. A fifth journal, *Coal Age*, was established in 1911 to cover a field which it had become evident was too broad to be successfully reached by the *Engineering and Mining Journal*, chiefly devoted to metal-mining interests.

Besides these enterprises in the field of American technical publications, Mr. Hill established branch houses in London and Berlin, where foreign editions of his journals were issued, and was President of the McGraw-Hill Book Co., publishing technical books.

An enterprise in which Mr. Hill took great pride and to which he devoted some of the best energy of the last years of his life was the construction on the upper west side of New York City, of the great building to house his publications, which was completed in 1914. It was characteristic of Mr. Hill that the building was not only planned at every point to suit the convenience and economy of the printing and publishing business, but that unusual provision was made for the safety, comfort and health of the army of workers housed in the building.

No more fitting monument to Mr. Hill could be erected than that which stands beside the main entrance to the publishing company's offices in this building. It is a handsome drinking fountain that was erected by the employees of the company and is inscribed:

Within this monument to independence, truth and service in engineering journalism, the employees of the Hill Publishing Co. have placed this tablet—an appreciation of the man and employer, John A. Hill.

The story of Mr. Hill's life gives a remarkable illustration of a man winning his way by sheer strength and ability. Born in the humblest surroundings and with only such education as was afforded by country schools in the woods of Wisconsin nearly half a century ago, he well proved the saying of the president of one of the leading American engineering colleges that "life itself is an education." From his early boyhood, in whatever occupation he was engaged, his personality was such that his associates instinctively recognized him as a leader. The impression he made on those who met him was invariably that of a man of strength and force. While he was typically a self-made man, he had none of the objectionable conceit which is sometimes supposed to characterize men who have risen to power from humble beginnings.

Mr. Hill was by nature modest and retiring. He was a genial man, fond of companionship and with an endless fund of good stories, but social life and club life had little attraction for him. His two chief interests were the enterprises he had created, in which he took such pride, and his home.

Mr. Hill was essentially a man of broad human sympathies. He took a fatherly interest in the welfare of his employees and delighted to have them refer to him as "The Old Man," a term to which he indeed gave wide currency in his early writings on experiences in machine shops and locomotive roundhouses. Some of his practical views of life were reflected in his early writings, which were published in book form, among them "Stories of the Railroads" and "Jim Skeever's Object Lessons," written largely in the vernacular of the shop and intended to teach in an attractive way certain lessons. These books showed the genius of the story writer as well as the technical editor, as did indeed many other of the articles that flowed so readily from Mr. Hill's pen while he was active in his earlier years in technical journalism.

Mr. Hill was a member of the Campfire Club, the Railroad Club, the Engineers Club and the Machinery Club, of New York City, and was Vice-President of the latter. He had long been a member of the Methodist Church in East Orange, where he had his residence. He was elected a member of the American Society of Mechanical Engineers in 1913, among his references being Thomas A. Edison and James Hartness. He was one of the representatives of this society on the recently appointed Naval Advisory Board.

Mr. Hill was married in Wisconsin in 1882 to Emma B. Carlisle, who with one daughter survives him.

Automobiles Taking Traffic from the Railways

A street-railway official, meeting a friend who had grown gray in steam-railway service, related his troubles with jitney-bus competition, winding up with the declaration that laws ought to be passed which would put the jitneys out of business. The steam-railway man listened patiently and then replied, smiling:

I know just how you feel, for we felt the same way about ten years ago when your interurban trolleys paralleled some of our lines and took away a good share of our most profitable business. You deserve the help of the law about as much as we deserved it then, and you will probably get just about as much help from that source as we did.

But I can sympathize with you, for we are each of us hit and hit hard by the automobile—not only the jitney bus, but also the privately owned car and the motor stage. There is a county fair held on my system, to which up to five years ago we used to carry 27,000 people annually. This fall we hauled 5,000 people to that fair. The rest came in automobiles.

People used to save their money and spend it on our excursions. Then you street-railway people came in and took most of the excursion business away, with your pleasure parks and lines running out into the country. Now people are spending so much money on their motor cars that they only ride in your cars or mine when they must.

The growing competition of the automobile with both steam and street railways is a matter receiving some attention, but deserving even more. It is serious in all parts of the country, but on the Pacific Coast it is greater than anywhere else. Here the mild climate and infrequent rains make motor riding comfortable the year round; the roads are surprisingly good, comparing favorably with the expensive roads of the East, although built at a tenth of the cost. In Los Angeles County, California, there are over 50,000 automobiles registered. The streets of the city literally swarm with them. There are jitney busses in scores, but there are probably ten times as many private cars and most of them are carrying people who would ride on street railways were the low-priced machines not available.

A common idea concerning the automobile is that it has robbed the street railways of the profitable short-haul business and left them the unprofitable long-distance riders. In Los Angeles, however, the motor car is at least equally important in carrying people to the distant suburbs of that remarkable metropolis in much shorter time than either electric or steam cars. Hundreds of business men go to town in the morning in their machines and return at night over a distance of five to fifteen miles.

An interesting study of street traffic in Denver was made last season by Roger W. Toll, Chief Engineer of the Denver Tramway Co., and is published in the "General Electric Review" for January. A careful traffic count showed that on Tuesday, May 5, 1914, the street cars of Denver carried 6.6 times as many passengers as were carried in automobiles. A year later, on Tuesday May 11, 1915, the street cars carried 3.9 times as many passengers as automobiles. On Sunday, May 9, the number of pleasure riders caused a further increase in motor traffic and there were only 3.1 times as many street-car passengers as automobile riders.

Most surprising of all is the development of automobile stages carrying passengers comparatively long distances for lower fares than the steam railways. Between Los Angeles and San Diego the railway passenger fare is $3.75. There are half a dozen lines of motor stages running between the two cities carrying passengers in seven-passenger cars, not new but in excellent condition, charging $2.50 and making the run of 135 miles in six hours. Were it not for the slackening of speed in entering Los Angeles and over stretches of ordinary dirt road (the state highway not being fully completed) the run could be made in shorter time, as over much of the distance a speed of some 30 miles an hour is maintained.

Even more remarkable is the motor-stage service between San Diego and El Centro, in the Imperial Valley. The distance is the same as to Los Angeles—135 miles; but the route is over ordinary earth roads, and a summit elevation of some 4,800 ft. has to be attained. There is no railway competition here, the nearest present rail connection being the long roundabout journey by way of Los Angeles. The fare charged by the motor stages over

route was formerly $5, but competition between the different stage lines has reduced this to $2.50, and some of them even reduce this to $4.50 for the round trip, a rate of only 1⅔c. per mile.

It is probable that this rate is below the actual cost to those who run the stages, if all the items of interest, taxes and depreciation were included, for even if a vehicle averaged six passengers per trip, its earnings would be only 10c. per mile. The expense for gasoline, tires and drivers' wages can hardly be less than 7c. per mile. On the other hand, the cars used are second-hand cars, bought doubtless at a low price and yet capable of a large amount of service; and there appears to be a steady supply of such cars available for purchase by those who run jitney busses and motor stages.

Even if the fare by the motor stage were as high as, or higher than, the fare by the steam railway, a good many travelers would prefer the motor stage. For one thing, it will carry a passenger clear to his destination in the city, while by the steam railway he has still a journey by the street car or hack when he reaches the railway station.

It may be well to again emphasize that the competition of the privately owned automobile with the railway is all the time growing. It is not merely the wealthy and the well-to-do who are habitually using motor cars. In the country districts especially, where most of the travel by road is for business and not for pleasure, the motor car has become a very democratic vehicle. And the farmer or the carpenter or the grocer who owns a motor car doesn't patronize the railway when he has a journey of a dozen or twenty miles, or even of fifty miles. In favorable weather, at least, he takes his own car and can go and return when he pleases, regardless of railway time tables.

In recent years steam-railway officers have awakened to the fact that a large proportion of their passenger traffic is carried at a loss; and this loss will increase as more of the business is diverted to other channels, for a large proportion of the items of cost in handling passenger traffic cannot be reduced as the business falls off.

Ninety years ago the development of the locomotive by Stephenson took away the business of the English stage-coaches. Many were the maledictions hurled against the new steam wagon by those who found their business ruined. All their efforts were fruitless, however, and it seems equally fruitless to block in any way the present movement to turn passenger travel away from the railway and back to the common roads. It is simply one of those economic changes that come about as a result of the work of the engineer and inventor.

When Storage Batteries Menace

Do electric-storage batteries constitute a general menace to life and property? This question has come up anew as a result of the sensational explosion that on Jan. 15, 1916, wrecked the United States submarine "U-2" in the dry dock of the New York navy yard. Since then the newspapers of the country have featured such garbled reports of pseudo-official findings as to the cause of the disaster that there is some excuse for general alarm. Fortunately we are able to show that, while some possibility of danger may exist wherever any storage battery of size is employed, there need be no apprehension that this most useful device is to be shunned. The hazard from a storage battery is very similar to that from a gasoline engine, and much the same precautions are demanded for the use of either in inclosed spaces.

It does not matter for the present whether or not the "U-2" really was wrecked by the explosive combustion of hydrogen evolved from the storage batteries. It does not matter whether the Edison or the lead battery was used. It is sufficient to know that hydrogen will be evolved in quantity from all the cells of any battery during charging, and that it may be released from a few of the cells when an attempt is made entirely to exhaust the energy of the battery. If the local conditions are such that a rich hydrogen-air mixture can be pocketed and exposed to chance spark or flame, a severe explosion is inevitable. The situation is analogous to many careless installations of gasoline engines where leaky pumps, pipes and valves let volatile hydrocarbon spill out into the room.

The remedy is obvious—care and brains (hired, if necessary) in selecting the location for a storage battery and in fitting up the place. The ventilation of battery compartments and room must be certain and ample, and inverted pockets (for hydrogen is a very light gas) must be completely suppressed. As an extra safeguard, every known source of arc, spark or flame must be guarded against. If such measures are taken and a reasonably vigilant maintenance secured, then the owner and the designer of battery plant need not fear disaster.

Tests of Column Strength

The splendid array of figures produced by the Bureau of Standards and the Column Committee of the American Society of Civil Engineers confirms satisfactorily most of the present views as to column strength. In addition, however, it gives warning that the strength of certain columns is perhaps often overestimated by 10 to 15%, or more.

It has been considered an axiom that the strength of a column is limited by the yield-point of the material. The tests confirm this view and convert it into an established fact, in spite of their failure to cite the yield-point values. However, some uncertainty has prevailed as to whether the extreme fiber governed in this regard. One phase of the question is covered by the tests so far made, and the answer is that extreme-fiber stress does govern. A section having thin outstanding edges in which, due to local buckling and the like, the yield-point is reached by the extreme fiber earlier than in a stocky section, has lower strength; the failure of the edge fibers initiates the failure of the section as a whole. Another phase must still be investigated. A column loaded transversely in addition to its column load has an extreme-fiber stress very much higher, and its strength should therefore be very much lower, than that of a column without transverse load. Does failure here also take place when the extreme fiber reaches the yield-point? Tests directed at this question are to be undertaken in future by the Bureau of Standards.

The wholly new and surprising fact disclosed by the test results is that tensile-test figures may be dangerously misleading if used as a guide in estimating column strength. The amount of error may be 3,000 to 6,000 lb. per sq.in.—a very serious amount.

In the course of the tests it appeared that columns of thick material were in all cases weaker than similar col-

umns of thinner material. Such an effect would be natural if the thick material were softer than the thin material, as it usually is. But the specimen tensile tests showed on the contrary a higher yield-point for the thick material. This left the case a mystery, until compression tests were made on short pieces sawn from the columns which had already been tested. Extensometer measurements on these short blocks showed that the compressive yield-point of the heavy sections was materially lower than the tensile yield-point by no less than 6,000 lb. per sq.in. For the light material there was little or no difference between tensile and compressive yield-points.

The observation not only furnishes a full explanation of the lower strength of the thick columns, but at the same time it indicates that the tensile yield-point must not be taken as strength criterion in proportioning columns. It suggests, in logical sequence, that acceptance tests of column material should be made in compression, not in tension.

One question remains. Must *all* columns of thick material be considered less strong than those of thin material? There is no sure basis yet for answering this question. The steel for the column tests was special material, made and manipulated in such way as to give uniform specimen-test results. This is not necessarily the same condition as that of commercial bridge steel. The Column Committee might well provide further information to show whether the heavy columns of their tests are to be considered made of special steel.

Seventeen Heads Off at Once

Mayor Curley of Boston sharpened up his political ax the other day and chopped off the heads of 17 members of the executive staff of the Department of Public Works of Boston. Many of these men were engineers, some holding important positions, and all had been in the employ of the city from 7 to 41 yr. Nevertheless, off went their heads with only 48 hr. notice. The only real accusation against these men which has yet got outside of Boston is that they were not politically active. All these employees were nominally under civil service, but all the worthy mayor had to do to steer clear, as he understands it, of civil-service regulations, was to abolish the positions. This of course is a mere farce, as the mayor himself not only admits, but in effect declares; for he says all the positions will be filled sooner or later, only perhaps not under the same title.

Of course the positions will be filled. Anyone has only to look at the list given elsewhere in this issue to see that they must be filled. Interest is added to Mayor Curley's action by the fact that in December the voters of Boston, under a peculiar twist of the recall idea, recorded an actual but not a statutory majority in favor of having an election for mayor in January. This "vote of confidence" in Mayor Curley apparently gave strength to his political arm.

Even though Mayor Curley puts equally competent men in the place of those removed, his action should none the less be condemned, since the whole principle and practice of wholesale removal from office for political purposes is viscious in itself and invites endless repetition and a weakened morale. The incident demands sharp condemnation by the engineering profession of Boston. What action will it take?

Duplicate Water-Supply Mains or Nearby Storage

That even two water-supply conduits do not insure a city from danger of a water famine unless there is ample water storage at the city end of the conduits has been demonstrated anew by the recent experience of Seattle. That city gets water from Cedar River, through two long wood-stave pipe conduits. The older of these was out of commission for extensive repairs when a break occurred in the other one. A part of the city without storage facilities was immediately deprived of water, the scanty amount of stored water in another section was soon depleted, and still other parts of the city might have gone dry had it not been possible to repair the broken conduit in about three days. Shortly after the water service was restored, a minor accident to the conduit again threatened to cut off the water-supply.

In the local discussion following these incidents much more attention seems to have been given to the advocacy of a third conduit—of "steel and concrete"—than to the provision of additional storage facilities. The newspapers, at least, assume that the great present danger lies in dependence on wood-stave pipe. They urge that Tacoma and Denver are the only other cities of size in the United States dependent on wood conduits and that Seattle should not lag so far behind the procession, which proves nothing as to the merit of wood pipe.

It does not necessarily follow that in a multitude of conduits there is safety. Certainly duplicate conduits, urged so often in various parts of the country, have failed Seattle twice—a few weeks ago and in 1911. The accident of 1911 is illuminating. The two conduits crossed a stream on one and the same bridge. The bridge and both conduits were wrecked by a flood, and the entire water-supply of Seattle was cut off. Had there been three or a dozen conduits leading from the same source of supply down a narrow valley and across a single bridge, the chances are good that an accident to one would have wrecked the three or the dozen pipe lines as completely as it did the two.

This is not all. It is a cardinal principle in waterworks and in fire-protection engineering that any city dependent upon a single and distant source of water-supply should have sufficient storage at the city end of its conduits to tide over any period during which the supply might be cut off by accident. In lieu of this, some emergency source of supply must be available. There is always a likelihood that these emergency supplies may themselves be a source of danger, if used for domestic as well as fire purposes. Happily, chlorine disinfection is now available as a very considerable safeguard, if not an absolute protection when these nearby emergency and probably polluted supplies are brought into service.

Coming back to Seattle, it is to be hoped that the city fathers will secure and follow sound engineering advice before deciding whether to build a third conduit or provide more storage. It is conceivable that the water-supply should be reinforced by both means, but it would be rash to embark on such a project without taking competent advice regarding the possibilities of a combination of additional storage and of a special fire-protection water-supply from abundant nearby sources, as has been recommended by the city engineer, the superintendent of waterworks and the fire underwriters for some years past.

Letters to the Editor

Patents on Reinforced Concrete

Sir—In the editorial comments upon the letters of F. A. Camp and H. T. Eddy regarding patents on reinforced concrete, published in *Engineering News* of Dec. 23, 1915, pp. 1236 to 1238, it is said that perhaps the best answer to the arguments presented by the correspondents named is the quotation from the opinion of Mr. Justice Bradley in Atlantic Works vs. Brady (107 U. S., 192) in which the learned justice said: "It was never the object of those [the patent] laws to grant a monopoly for every trifling device, every shadow of a shade of an idea, which would naturally and spontaneously occur to any skilled mechanic or operator in the ordinary progress of manufactures."

The case of Atlantic Works vs. Brady, decided by the Supreme Court of the United States in October, 1882, was begun Apr. 9, 1868, and involved the validity of a patent granted Dec. 17, 1867, to Edwin L. Brady. The court found that all of the details of Brady's alleged invention were in fact the design of General McAlester, of the United States Engineer Corps, and had been communicated by him to Brady prior to the application for the patent.

Since Brady was not the inventor, no valid patent could be granted to him, and in view of this fact the court's epigram as to the "shadow of a shade of an idea" was wholly unnecessary and has the appearance of having been thrown in for good measure. While absolutely true as a statement concerning the object of the patent laws, it has no necessary bearing on the case in question and has worked harm by encouraging the use of false standards in appraising invention.

The case of Atlantic Works vs. Brady is an old one, finally decided 34 years ago, and the pronouncement of the Supreme Court in Diamond Rubber Co. vs. Consolidated Tire Co., decided October, 1910 (220 U. S., 428), should be of greater interest because it is a more recent and pertinent expression of the court's view of patents. In this later case Mr. Justice McKenna said of the alleged invention in suit:

> It possesses such amount of change from the prior art as to have received the approval of the Patent Office, and is entitled to the presumption of invention which attaches to a patent. Its simplicity should not blind us as to its character. Many things, and the patent law abounds in illustrations, seem obvious after they have been done, and, "in the light of accomplished result" it is often a matter of wonder how they so long "eluded the search of the discoverer and set at naught the speculations of inventive genius." Knowledge after the event is always easy, and problems once solved present no difficulties, indeed, may be represented as never having presented any, and expert witnesses may be brought forward to show that the new thing which seemed to have eluded the search of the world was always ready at hand and easy to be seen by merely skillful attention.
>
> But the law has other tests of the invention than subtle conjectures of what might have been and yet was not. It regards a change as evidence of novelty, the acceptance and utility of change as a further evidence, even as demonstration. And it recognizes degrees of change, dividing inventions into primary and secondary, and as they are one or the other, gives a proportionate dominion to its patent grant. In other words, the invention may be broadly new, subjecting all that comes after it to tribute; it may be the successor, in a sense, of all that went before, a step only in the march of improvement and limited, therefore, to its precise form and elements as the patent in suit is conceded to be. In its narrow and humble form it may not excite our wonder as may the broader or pretentious form, but it has as firm a right to protection.

In concluding your comments on the subject of "Patents on Reinforced Concrete" you say: "The position of the engineering profession almost without exception is that the designing engineer should not be obstructed in his regular routine work by patents issued to some other designer merely because the latter has devised some particular arrangement of parts, without making any real advancement in the art such as justifies the Government in its grant of a monopoly."

The point at issue is: Does the positioning of steel in reinforced concrete to produce a new and useful result amount to invention? It is not sufficient to say that it was "within the ability of any competent engineer experienced in reinforced-concrete design" so to do, if in point of fact competent engineers skilled in the art did not so do until the inventor and patentee had shown the way. One must go farther and examine the state of the art, that is, learn what competent engineers had already done and what they were then doing in the way of designing when the alleged inventor entered the field. From what had been done before and from what those skilled in the art were doing at the time, the courts seek to deduce the state of men's minds and thus judge whether a given new and useful improvement is merely the natural product of engineering skill or whether it comprises that additional element defined as invention.

The first test of whether an improvement is a "real advancement in the art such as justified the Government in its grant of a monopoly" is the action of the Patent Office. The next test is whether designing engineers insist upon making use of that improvement. If an improvement is not a real advancement in the art, the competent designing engineer should have no difficulty in finding plenty of substitutes and thus need not be obstructed by the patent. On the other hand the greater the obstruction to the designing engineer the more certainly is there invention in the obstructing plant.

DANIEL ROYSE.

Indianapolis, Ind., Jan. 7, 1916.

Freight Traffic Routes Around Large Cities

Sir—Referring to the editorial, "Routes for Freight Traffic Around Large Cities," in your issue of Jan 13, in the second paragraph you state that the Pennsylvania R.R. built a line around the City of Baltimore for the use of its through freight trains.

This has never been accomplished. The route was located during the presidency of the late A. J. Cassatt and would have been built at that time, but the residents of Baltimore were opposed to a railroad through the northern section of the city and secured legislation that

prohibited any new railroad construction within that area. Since then the Pennsylvania R.R. has had to content itself with working its traffic through the tunnels in the City of Baltimore as best it could. On account of the development in recent years in the northern section of the city, such a line is probably impracticable at the present time.

We, however, have many routes that keep through freight out of yards and terminals. For example, in completing the six-track system from Pittsburgh to New York, we located the additional two tracks on new routes to avoid congested areas—notably the new double-track line on the west side of the Susquehanna River, opposite Harrisburg, from Enola yard through to Morrisville, near Trenton, thus avoiding the traffic in and around Philadelphia. At Pittsburgh the Brilliant cutoff was constructed to exchange traffic from the main line near East Liberty to our lines on the east and west banks of the Allegheny River, at Brilliant and Aspinwall. Our company and the Delaware & Hudson Co. have recently formed the Wilkes-Barre Connecting Railroad Co. to keep through freight traffic out of the City of Wilkes-Barre with its grade crossings.

There is no provision in the charter or in the New York City franchise under which our tunnels and station were built, to prohibit the movement of freight trains, and when the matter was under consideration by the aldermen, we declined to accept a limited franchise of that kind. We did say, frankly, that the tunnels were built primarily for passenger traffic and would be so used. We feel that the movement of our through freight via Greenville and the Bay Ridge transfer, later using the New York Connecting R.R. instead of the 12 mi. of East River floatage, will be more regular and expeditious than if it were marshaled on the meadows to await the early morning hours for movement through the tunnels to Long Island and the New Haven system. SAMUEL REA,

President, Pennsylvania Railroad Co.

Philadelphia, Jan. 17, 1916.

Are Eccentric Details Weak?

Sir—In *Engineering News* of Nov. 25, 1915, R. Fleming by inference, judging by the examples he cites, would throw discredit on the theory that eccentric application of load is damaging to connections and members. There is some truth in his contention, but the truth lies not in condemnation of the theory but in failure to apprehend all of the conditions of the theory.

The theory of flexure presupposes a material that is perfectly elastic. It does not take into account the toughness or ductility exhibited beyond the elastic limit.

By virtue of toughness, many structures persist in standing and carrying their load in spite of theoretical stresses that would cause them to collapse. On the other hand, reliance on the toughness or ductility of steel gives rise to a large class of failures: Many members carry loads that theoretically ought to break them and that eventually do break some of them.

In structural work, columns are often milled out of square, and they bear on one corner or one edge. Theoretically the stress produced by this condition is much more than the ultimate strength of the steel, but the columns continue to carry their load without any apparent distress. Is the theory therefore at fault? Not at all. The theory tells what would happen in a perfect elastic material, and if steel were perfectly elastic, like glass, doubtless the columns would crush and fail. In the case of a badly milled column, if slenderness and deflection did not enter, at the corner where excessive pressure existed the metal would probably be peened down by the excessive pressure; little or no damage may be the result.

Much space is taken up in engineering literature in describing the calculation of secondary stresses such as those due to the friction of rotation of members on pins, and similar causes. Such calculations are practically of no value, because such stresses are of no consequence, and this is because of the toughness of steel. The kneebrace under a girder could be shown to have theoretically a tremendous stress due to deflection of the girder; and yet if that kneebrace were sawed in two, nothing would happen.

As pointed out by Mr. Fleming, the addition of rivets to a joint, making it eccentric, may result in weakening the joint theoretically. Doubtless in a test this apparently weaker joint would prove stronger in this particular case, and such experimental demonstration would seem to nullify the theory. Here again the factor of toughness enters; also a further fact, namely, that rivets do not join metal so as to make the connected pieces like one piece. Under test there is a small slip in the rivets, and this brings about a readjustment of the stresses on the rivets. Thus a joint may adjust itself to adverse conditions and hold where the theory would predict failure. These facts are cited not as justification for reckless design of riveted joints, but as explanation of why many recklessly designed joints do not fail. Proper design should take care of eccentric application of loads on riveted joints.

Theoretically if a bar is doubled in width by adding to one side only, the member is weakened. Practically if a test were made, the bar, if of steel, would probably be stronger in spite of the eccentric application of the load. If the addition had been made by riveting on metal, the advantage might be even more in favor of the wider bar, for the reason that slip in rivets would probably allow practically the whole of the original bar to come into play with uniform intensity of stress. Proper application of theory would discover these facts. But the designer is not thereby justified in using eccentric members without due provision being made for the bending moments.

In the case of tension members, especially those subject to repeated loading and eccentric stress, failure sometimes results after many repetitions of the load. This is particularly true of such things as chains and hooks. Chains and hooks that have carried many loads sometimes fail under the same load as one previously carried. Calculations will show that the load produces unit stresses equal to or greater than the elastic limit of the steel. The metal is rendered brittle by repetition of this strained condition, and failure eventually takes place. Contractors anneal their chain from time to time to counteract this brittle tendency. This is virtually a confession that the chain is strained beyond its elastic limit, else it would never need to be annealed.

Permanent structures never need to be annealed if they are properly designed and eccentric stresses taken care of. Theory is the proper thing to be guided by in this, and not test. Tests would have to be repeated many thousands of times to be conclusive.

In an elevator hitch made of two steel straps, 3x⅝ in., bent with two right-angle bends and offset about 2½ in., calculations showed a unit stress of 20,800 lb. per sq.in. for an elevator load of 3,250 lb. And yet that load and more, with its shock, was carried for years. But it was carried once too often, and the elevator dropped. Tests were made of similar straps, and one of them stood 32,000 lb. This would seem to defy the theory. But among the tests one stood only 6,300 lb. What is the explanation of this difference? Simply, toughness. The strap that stood the high test straightened out; the one that stood the low test broke without straightening. If the high test had been taken as a criterion and a factor of safety of 10 assumed, it would appear that a load of 3,250 lb. could be safely carried indefinitely.

The proper criterion is the theory that discovers just what stress exists on the extreme fiber of this strap at the bend. If this stress be kept within safe limits, the connection can be loaded an endless number of times without danger of failure. If the stress is near or above the elastic limit, failure may be looked for after a large number of repetitions of the load. If it were compression that is excessive and not tension, the result might be a bending of the part without rupture.

EDWARD GODFREY.

Pittsburgh, Penn., Jan. 4, 1916.

A Sinking-Fund Delusion

Sir—Permit me to discuss the editorial note in your issue of Dec. 30, 1915—"A Sinking-Fund Delusion." In comparing the "straight-line" and "sinking-fund" schemes you say, "Claiming that one plan is cheaper than the other is only doing a trick in words or in bookkeeping."

If we could be sure of the correctness of our assumptions as to expected life of the several parts of plant, then the difference in the cost of this item of so-called depreciation could be practically shown by a simple computation. Take a 40-year life on a plant valued at $100. On the straight-line system there will be charged to operating cost, and so should be covered in the rates, 40 × $2.50 = $100. If this liability for renewals is met through a 4% sinking fund, the annual payment will be $1.05, and for the 40 years the total charged into operating cost will be $42; that is, the interest accumulations will pay the balance, namely, $58. With a 5% sinking fund, the annual payment will be $0.83, and the total charged into operating cost will be $33.20, the interest accumulations paying the required balance of $66.80.

Now let us see if the customers pay the $58 out of the $100 in the 4% sinking-fund case, or the $66.80 out of the $100 in the 5% sinking-fund case. If the annual payments are invested year by year in securities—in other words, treated as a true sinking fund—certainly the customers do not pay the $58 or the $66.80. The borrowers of the money pay the rent therefor. If this reserve for "depreciation" (renewals) is invested in additions to plant, then these additions to plant have to earn the $58 or the $66.80. Again the customers do not have to pay.

If there is any delusion in the consideration of this matter, it certainly is in the method suggested by Mr. Stearns. It is highly ingenious, but I have been unable to discover any other merit. In fact I consider Mr. Stearns' treatment of this subject a most regrettable addition to the already unfortunate confusion in the minds of many who have discussed this important subject.

As to your reference to court decisions, permit me to say that they do not alter facts..

One prominent reason for the confusion of thought on this subject, and particularly in connection with the proposition to deduct this so-called depreciation in the valuing of plants for rate-making cases, is in the confounding of actual depreciation with the setting up of a reserve to cover the future renewals of plant—necessarily deferred, and necessarily an accruing liability. If the circumstances in any particular case are such that the annual payments for maintenance are approximately the average of total cost for repairs and all renewals, then there is of course no need for a reserve, and this question settles itself. But in many cases, and probably most cases, a reserve has to be set up by charging to operating cost, as otherwise there would be in most years an inflated statement of profits. *The only object of such a reserve is to spread uniformly over the years the total cost of maintenance.*

If we trained ourselves to refrain from using the term "depreciation" in this connection and labeled our reserve with the term "renewal," or "deferred renewal," or "periodic renewal," or "final renewal," we would escape much of the confusion which has troubled lawyers and judges—yes, and engineers and editors.

ALEX. C. HUMPHREYS,
President, Stevens Institute of Technology.

Hoboken, N. J., Jan. 12, 1916.

[It is universally conceded to be the duty of customers of a public utility to pay for the entire cost of service, including compensation for depreciation of the service plant; the utility should not be forced to secure foreign profits to relieve the consumers of legitimate burdens. In the hypothetical case cited by President Humphreys, where he believes that interest on loans is relieving the customers of a part of their legitimate burden, the consumers pay the depreciation indemnity in full—only they pay part of it under disguise of interest on capital which actually has been lost through service. The $1.05 or the $0.83 put into sinking funds or extensions is not free capital; it earns only for its own proper aggrandizement. To make up for the funds thus rendered unavailable, equity demands some equivalent, and this is conveniently secured by use of a rate-basis worth untouched by depreciation deductions. President Humphreys would use this larger rate-basis worth, and the customers would not escape the $58 or $66.80 as the case may be. This is the "trick in words or bookkeeping" which the direct-repayment plans of compensating for depreciation put aside. The danger to some utilities of this fiction, in view of the Knoxville decision, lies in the probability that the part of depreciation indemnity fictitiously parading as interest on nonexistent worth will be cut off. Supreme Court decisions do not alter physical facts, but they do fix the law of the land, and whether original full or present diminished value shall enter public-utility rates may be made a matter of law.

Translating "depreciation indemnity" or "depreciation compensation" into "provision for renewals," or better still "provision for retirements," does clarify many public discussions and is to be recommended—but it does not change the underlying conditions discussed.—Editor.]

Railway Construction for New Halifax Ocean Terminals

The new ocean terminals at Halifax, N. S., as described in *Engineering News,* Dec. 9, 1915, p. 1118, comprise a landing quay and a series of piers in deep water (35 to 45 ft.) at the southerly end of the Halifax peninsula. In connection with these docks there are to be built a passenger station and a most complete system of warehouses, with freight-handling equipment—all in direct track connection with the terminal tracks of the Intercolonial Ry., the Maritime Provinces branch of the Canadian Government Railways. The provision for railway entrance to the docks, which is the dominating element in the whole port scheme, required a reconstruction of the Intercolonial Ry. for a distance of about 6 mi. to the water edge from the present entrance of the railway to the city proper.

The old railway terminal, a construction of 50 yr. standing, is located on the east side of the city, under a sharp incline of land running up from the harbor there. Partly on account of the narrowness of the shore strip, but mainly because of the extensive present commercial utilization of this narrow strip, the removal of which would have been very expensive, it was decided to bring the railway from its present location on the west shore of Bedford Basin, north of the city, directly across the neck of land at the stem of the peninsula down the east shore of the Northwest Arm—the harbor branch that runs up behind the city. This decision was reached even after consideration of the objections to the scheme, which were in effect only two: The Northwest Arm shore is a beautifully wooded section given over practically entirely to park and residence property, and there was considerable opposition to the running of a railway through it, particularly on the waterfront itself, where the best location could be obtained. The second objection was the technical one, that the topography was such that any location involved very much more cutting than filling.

The first objection was met by moving the line well back from the waterfront, so that the æsthetic damage is slight and every crossing can easily be carried above railway grade. The preponderance of cut over fill was cared for by disposing of the spoil at the new freight yards being built to the north on Bedford Basin and in the breakwater and behind the quay walls of the harbor improvement.

The new line is 6¼ mi. long from the Bedford Basin freight yard to the terminal and is two-track for all the distance except in the terminal area, where it branches into four tracks. It is practically all in cut through a shale formation in contact with granite. About 1,750,000 cu.yd. of excavation is to be made. The deepest cut is 60 ft.

The rock at first proved rather difficult of removal, and a number of different methods of drilling were tried out. On account of the seamy nature of the rock, small drills could not be successfully used, mainly on account of frequent and annoying binding. After a number of trials well-drills of the Cyclone type, electrically driven, were installed, and they were operated with conspicuous success.

These drills were sent up through the cuts in gangs, working ahead of the shovels without regard to the location of the latter. As each drill hole was made, it was capped and left for the shooting, which kept right ahead of the shovels. The cuts below 30 ft. were shot in one bench, those above that depth in two. The areas blasted at one time included the full width of the cut over lengths of from 100 to 200 ft. In these areas each drill hole was filled with a 65% nonfreezing forcite and the whole area was shot at once. The two views in Figs. 1 and 2 show such a section before and after shooting. In Fig. 1 the caps to the drill holes may be noticed.

FIGS. 1 AND 2. BEFORE AND AFTER A BIG BLAST ON THE RAILWAY APPROACH TO THE HALIFAX OCEAN TERMINALS AT HALIFAX, NOVA SCOTIA

Fig. 1 (Left)—View along cut after well-drill casings have been placed. Fig. 2 (Right)—Same view after the blast

Behind the blasts the steam shovels worked, loading onto dump-car trains which carried to the freight yard on the north section and to the breakwater on the south. There were two Bucyrus 3½-yd., 100-ton shovels, one Bucyrus 2½-yd., 70-ton shovel and two Marion 2½-yd., 60-ton shovels. The 3½-yd. shovels loaded into 12-yd. dump cars, and the smaller shovels into 4-yd. cars. The large stone from the well-drill blasts was carried mainly to the breakwater, where it was dumped from the floating dumping bridge, described in *Engineering News,* April 1, 1915, p. 634.

The first shots did not break up all the material small enough for loading, so the bigger stone was reduced after

drilling with small drills driven from air compressors located on the steam shovels. For the benchwork electric drills of the Ingersoll-Rand Temple type proved most efficient.

The view in Fig. 4 gives a good idea of the character of the country through which the road runs and shows also one of the few fills and the round-timber trestles used for the fill. The freight yard is made by side dumping of big rock out into the water of Bedford Basin from tracks gradually moved over onto the new fill as made. Practically all of the cut and fill work is now

FIG. 3. WORKING ON THE BENCH OF ONE OF THE CUTS OF THE HALIFAX OCEAN TERMINAL RAILWAY

complete, and the grade-crossing bridges, which are to be mainly of concrete, are to be finished next season.

The railway contract is held by the Cook Construction Co., Ltd., and Wheaton Bros., with Andrew Wheaton and I. J. Bowes in charge. The ocean terminals are being built by the Department of Railways and Canals, under the direct personal supervision of F. P. Gutelius, General Manager of the Canadian Government Railways. Design and construction are in immediate charge of James McGregor, as Superintending Engineer.

British and American Patents on Activated Sludge

It has been generally assumed in this country that the use of the activated-sludge process, with whatever form of tank anyone might devise, is free to all. This assumption was natural, since until recently there has been no public mention of patents on either the tank or the process, except that a United States patent on both, granted to Leslie C. Frank, of the United States Public Health Service, had been dedicated to the public. Late in 1915 statements were published in the London *Surveyor* to the effect that activated-sludge patents had been taken out by Jones & Attwood, hydraulic (manufacturing) engineers, of Stourbridge, England. It was intimated that American engineers and cities had better "watch out." As Milwaukee was mentioned in the *Surveyor*, a letter was sent by *Engineering News* to T. Chalkley Hatton, Chief Engineer, Milwaukee Sewerage Commission, asking for information on the subject from the Milwaukee viewpoint. Mr. Hatton's response follows:

Jones & Attwood, hydraulic (manufacturing) engineers of Stourbridge, England, have secured letters patent through the English Patent Office on apparatus for applying the activated-sludge process to the treatment of sewage and analogous liquids. So far as these patents have been published they are as follows: No. 22,952, Oct. 11, 1913; No. 729, Jan. 10, 1914; No. 19,915, Oct. 11, 1913; No. 19,916, Apr. 11, 1914. Jones & Attwood have also filed application for letters patent in the United States Patent Office, which application is still pending before the examiner.

On May 1, 1915, letters patent No. 1,139,024 were granted by the United States Patent Office to Leslie C. Frank, of Washington, D. C., upon the "process of purifying sewage or other waste and apparatus therefor," which patent was dedicated to the public by Mr. Frank.

While not intending in any way to argue the relative standing of these two patents, it might be interesting to state that after a careful examination of the claims made by the Jones & Attwood patent and the Frank patent, it seems to be clear that the two are almost identical. Claims 7 and 8 of the Frank patent are:

Claim 7—The herein described process of purifying sewage, which consists in causing it to circulate, simultaneously oxidizing the same, causing some agitating agency to hold the sludge particles in the oxidizing portion continuously in suspension, permitting the sewage so treated to deposit its sediment in a relatively nonagitated portion of the path, removing the clear liquid and bringing the deposited sediment back into the agitated portion of the path.

Claim 8—Apparatus for continuously purifying sewage, consisting of an oxidation chamber, means for introducing

FIG. 4. ROUND-TIMBER TRESTLE ON ONE OF THE FEW FILLS ON THE HALIFAX OCEAN TERMINAL RAILWAY

sewage into the bottom thereof, means for introducing oxygen into the bottom thereof, a sedimentation chamber communicating with the upper portion of the oxidation chamber, means for returning the sediment into the oxidation chamber, means for removing the clarified liquid from the sedimentation chamber.

Claim 1 of the Jones & Attwood patent No. 22,952 is as follows:

The treatment and purification of sewage (and analogous liquids) by the aërobic process, by supplying the solid matters and liquid, and their contained bacteria with diffused fresh air delivered from the bottom of the treating tank, locally, and causing it to rise thereby, locally; and causing the liquid to return and fall down locally in the tank, separate, or away, from the rising volume of liquid and its contained solids and bacteria, and to again pass to the locality of air supply; so that the bacteria are continuously refreshed with air and rendered active; and the solids with which they are associated are continuously distributed and diffused throughout the liquid, and the whole contents are also continuously kept in circulation by the said air; substantially as set forth.

With the knowledge of the process and the apparatus required therefor it appears to me that these claims are identical. The Jones & Attwood patent was issued from the English Patent Office on Oct. 11, 1913, whereas the Frank patent was issued by the United States Patent Office on May 11, 1915. Whether the English patents will take priority of the American patents is a question for a lawyer to decide, but it occurs to me that if the United States Patent Office issues letters patent to an English concern upon a process for which it has already issued letters patent, it lays the foundation for expensive and endless litigation.

It is true that Doctor Fowler, of Manchester, England, designed the first experimental activated-sludge tank for Milwaukee, and that this tank was designed on the fill-and-draw principle, which was the only one that, at the time, Doctor Fowler believed could be made applicable. It is also true, however, that the first continuous-flow tank based on the activated-sludge process was designed by the Milwaukee Sewerage Commission, and after its design and construction, and in fact after the operation was started, the plans were submitted to Doctor Fowler for his criticism, but the doctor had nothing to do with its design, nor has he had anything to do with the design of our 2,000,000-gal. continuous-flow activated-sludge plant, although the plans were submitted to him after the contract for the construction was awarded, and no changes have been made from the original plans.

I only mention this to dispel any feeling on the part of our English friends that they are responsible for the continuous-flow principle, as carried out here in Milwaukee, and not to claim any honor for originality, because whatever honor there may be should be divided with not only the English experimenters, but with the American experimenters as well, because they have all been working to the end of developing the process upon practical lines; but I think there is no doubt upon the information at hand that the American experimenters discovered and have developed the continuous-flow principle.

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Tests of 180 Steel Columns

Great progress has been made during the year in the large-size column tests being carried out by the Bureau of Standards in coöperation with committees of the American Society of Civil Engineers and the American Railway Engineering Association. During the year, 110 columns were tested, making a total of 180.

The sizes of the column sections are in two groups, light and heavy, the light ranging from 8½ to 13 sq.in., and the heavy from 17 to 26 sq.in., being roughly in a ratio of 1:2. For every light section a corresponding heavy section is made and tested, thus getting the effect of difference in size of cross-section and thickness of material uninfluenced by difference of type. Three lengths of each column are tested, with length ratios $\frac{l}{r}$ of 50, 85 and 120. A still greater length, $\frac{l}{r} = 155$, is being built and will be tested for two or three of the sections. Certain sections are also being tested in very short lengths, $\frac{l}{r} = 20$, these pieces being cut from the longer columns after the latter have gone through the test. With two of the section types a third or extra-heavy size will be provided, carrying the range of cross-sections up to 28½ sq.in. (the light and heavy columns of this type being about 11 and 22 in.) and the thickness of material to ⅞ in.

A summary of the test results is given in the committee report in the form of tables which, omitting the ultimate deflections, are reproduced in a single table on the opposite page.

Column Formula To Be Reduced

The very regular falling off of strength with increasing length of column will enable the committee to deduce a more precise and more useful column formula than any in existence. On account of the large number of tests, the fact that they are of commercial size, the careful methods used by the Bureau in testing, and the uniformity of the material, the values shown by the tests are likely to be less vitiated by accidental variation than any prior single series or any collection of tests.

The material was specified to come within a narrow range of values of tensile strength, to represent the usual 60,000-lb. grade of bridge steel. The different thicknesses of plates and shapes vary slightly in chemical composition on this account.

SPECIMEN TESTS OF MATERIAL OF COLUMNS

Section	Tensile Yield-Point	Tensile Ultimate Strength	Composition % C	Mn	P	S
Column Type 1 (light)						
6x⅞ pl	36,220	60,100	0.20	0.47	0.010	0.038
5x3x⅞ angle	34,170	57,860	0.20	0.44	0.010	0.028
Column Type 1-A (Heavy)						
6x½ pl	36,860	58,250	0.20	0.40	0.020	0.032
5x3x½ angle	38,500	59,720	0.21	0.45	0.015	0.032

Existing views on the strength of steel columns are supported by the tests. The ultimate strengths ranged from 27,000 to 38,000 lb. per sq.in., the values for short columns (length = 50 radii) approaching or even exceeding the yield-point of the material.

Probably an important influence on this result was contributed by the straightness and perfect centering of the columns. They were specially made for the tests, with careful workmanship, and were free from perceptible bends and from kinking of the flanges from handling. In preparing them for the testing machine the ends were scraped to surface plate, at right angles to the axis.

That thin outstanding edges of a column section are a source of weakness is proved by the tests of type 6, which gave the lowest strength of any. Other sections are practically equivalent in strength for the same area and radius of gyration. Outstanding edges 3 to 4 in. wide are safe if they are ⅝ in. thick (under test conditions where the flanges are straight and uninjured).

There are no test data to show whether columns with local kinks or bends of the flanges are weaker than columns in straight and perfect condition; and if so, how much.

Column Strength Depends on Extreme-Fiber Stress

Column strength is limited by approach of the stress in the extreme fiber to the yield-point, in agreement with prior views. This stands out clearly from the reported figures. The influence of extreme-fiber stress is shown best in the case of type 6, previously mentioned, where the outstanding edges of the flange plate caused the column to fail at abnormally low stress.

The dominating influence of yield-point follows primarily from the fact that the column strength approaches

Type	Test no.	Section	Actual Area	Radius of Gyration	Length	l/r	Unit Ultimate Strength	Average Ultimate Strength
1	5	Light Sections	11.13	2.24	9'-4"	50	32400	
	37		11.17	"	"	"	32800	32700
	76		11.13	"	"	"	33000	
1A	15		11.49	"	15'-10½"	85	32100	
	89		11.49	"	"	"	31400	31200
	90	4-15"x5½"x¾" @ 9.60 lb. 1-PL 6½"x⅞" @ 1.875 lb. Total = 11.475 lb.	11.35	"	"	"	30000	
	28		11.20	"	22'-4¾"	120	28600	
	48		11.14	"			27600	28300
	51		11.30	"			28700	
2	33	Heavy Sections	22.25	2.36	9'-10"	50	29000	
	96		22.13	"	"	"	28900	29200
	97		22.28	"	"	"	29700	
	91		22.136	"	16'-8⅝"	85	28000	
	98		21.92	"	"	"	28200	28100
	95	4-15"x5½"x¾" @ 18.84 lb. 1-PL 6½"x⅜" @ 3.75 lb. Total = 22.15 lb.	22.05	"	"	"	28000	
	92		22.15	"	23'-7⅝"	120	25000	
	98		22.10	"	"	"	25500	25400
	99		22.10	"	"	"	25800	
1 Spec.	85A	Light Sections	11.35	2.24	9'-8¾"	50	35100	
	84A	as above	11.49	"	"	"	38000	36400
	84B		11.49	"	"	"	36100	
1A Spec.	99A	Heavy Sections	22.10	2.36	9'-11⅝"	50	45000	
	98A	as above	"	"	"	"	44100	44400
	95B		"	"	"	"	44100	
2	11	Light Sections.	10.06	2.31	9'-7⅛"	50	33100	
	41		10.15	"	"	"	34000	33900
	43		10.06	"	"	"	34500	
	21	3½"	9.92	"	16'-4⅜"	85	33700	
	39		9.87	"	"	"	32300	32600
	65	2-6"Dx10.5-lb. @ 6.18 lb. 2-PL 8½"x¼" @ 4.00 lb. Total = 10.18 lb.	10.05	"	"	"	31700	
	32		10.01	"	23'-1⅜"	120	28300	
	54		10.09	"	"	"	28700	29300
	70		10.07	"	"	"	30900	
2A	101	Heavy Sections.	17.07	2.33	9'-8½"	50	32200	
	124		17.07	"	"	"	32500	32300
	165		16.96	"	"	"	32300	
	143	3½"	17.07	"	16'-6¾"	85	30700	
	146		17.02	"	"	"	30000	30600
	151	2-6"Dx15.5-lb. @ 9.12 lb. 2-PL 8½"x⅝" @ 8.00 lb. Total = 17.12 lb.	17.11	"	"	"	31000	
	135		17.04	"	23'-3⅜"	120	28500	
	136		17.02	"	"	"	28800	28100
	137		17.08	"	"	"	27000	
3	1	Light Sections	8.71	2.34	9'-9"	50	33800	
	2		8.80	"	"	"	34300	34100
	42		8.71	"	"	"	34300	
	14		8.71	"	16'-6¾"	85	32500	
	87		8.69	"	"	"	31900	32400
	88	2-5"Dx6.5-lb. @ 3.90 lb. 2-PL 9½"x⅜" @ 4.75 lb. Total = 8.65 lb.	8.60	"	"	"	32900	
	24		8.79	"	23'-4⅞"	120	31600	
	35		8.70	"	"	"	30200	30600
	47		8.74	"	"	"	30000	
3A	105	Heavy Sections.	16.44	2.39	9'-11¼"	50	29800	
	168		16.45	"	"	"	29300	29500
	171		16.39	"	"	"	29500	
	147		16.41	"	16'-11⅛"	85	28000	
	148		16.39	"	"	"	28000	28000
	150	2-5"Dx11.5-lb. @ 6.76 lb. 2-PL 9½"x½" @ 9.50 lb. Total = 16.26 lb.	16.37	"	"	"	28000	
	138		16.50	"	23'-10⅝"	120	28000	
	139		16.45	"	"	"	26100	26900
	143		16.42	"	"	"	26600	

Type	Test no.	Section	Actual Area	Radius of Gyration	Length	l/r	Unit Ultimate Strength	Average Ultimate Strength
4	6	Light Sections.	11.69	2.38	9'-11"	50	35700	
	36		"	"	"	"	36500	36900
	75		"	"	"	"	38600	
	13		11.66	"	16'-10½"	85	34900	
	79		11.73	"	"	"	33900	34000
	80	2-8"Dx11.25-lb. @ 6.70 lb. 1-8"Dx18.00-lb. @ 5.33 lb. Total = 12.03 lb.	11.64	"	"	"	34900	
	26		11.69	"	23'-9⅝"	120	32000	
	45		11.61	"	"	"	30700	31900
	49		11.68	"	"	"	33100	
4A	102	Heavy Sections.	16.98	2.32	9'-8"	50	30300	
	166		16.84	"	"	"	29000	29100
	169		16.81	"	"	"	28000	
	132		16.86	"	16'-5¾"	85	26000	
	133		16.89	"	"	"	26400	26600
	134	2-8"Dx18.75-lb. @ 11.02 lb. 1-8"Dx10.50-lb. @ 6.03 lb. Total = 17.05 lb.	17.00	"	"	"	27500	
	132		16.98	"	23'-2⅝"	120	23500	
	133		17.07	"	"	"	23900	23900
	134		16.96	"	"	"	24200	
5	107	Light Sections.	9.62	1.98	8'-3"	50	38000	
	127		9.65	"	"	"	38000	38000
	123		9.65	"	"	"	38000	
	114		8.61	"	14'-0⅜"	85	36000	
	116		9.66	"	"	"	34000	34300
	119	Beth. 8"-H 61x32-lb. @ 9.17 lb.	9.59	"	"	"	33000	
	110		8.64	"	19'-9¾"	120	33900	
	111		8.58	"	"	"	31000	32000
	108		8.61	"	"	"	31000	
5A	106	Heavy Sections.	17.86	2.09	8'-8⅝"	50	34000	
	120		17.82	"	"	"	36100	35400
	121		17.86	"	"	"	36000	
	115		18.05	"	14'-9⅛"	85	33900	
	117		17.73	"	"	"	32000	32300
	118	Beth. 8"-H 61x32-lb. @ 18.27 lb.	17.77	"	"	"	31000	
	109		17.76	"	20'-10⅞"	120	30000	
	112		17.97	"	"	"	30000	30000
	113		17.73	"	"	"	30000	
6	10	Light Sections.	13.72	2.31	9'-7⅛"	50	31200	
	40		13.78	"	"	"	31500	31600
	44		13.72	"	"	"	32200	
	22		13.65	"	16'-4⅜"	85	27800	
	63		13.68	"	"	"	29500	29100
	64	1-10"x25-lb. @ 7.37 lb. 2-PL 11½"x⅝" @ 6.88 lb. Total = 14.25 lb.	13.60	"	"	"	30100	
	31		13.73	"	23'-0⅝"	120	26700	
	52		13.75	"	"	"	27700	27200
	71		13.65	"	"	"	27300	
6A	103	Heavy Sections.	23.98	2.47	10'-3¾"	50	31200	
	125		23.75	"	"	"	32800	32100
	128		23.72	"	"	"	32400	
	155		23.69	"	17'-5¾"	85	27200	
	158		23.73	"	"	"	26400	26800
	159	1-10"x35-lb. @ 10.29 lb. 2-PL 11½"x⅜" @ 3.75 lb. Total = 24.04 lb.	23.72	"	"	"	25400	
	129		23.64	"	24'-8⅜"	120	24900	
	130		23.83	"	"	"	24000	24800
	131		23.76	"	"	"	25500	

Type	Test no.	Section	Actual Area	Radius of Gyration	Length	l/r	Unit Ultimate Strength	Average Ultimate Strength
7	5	Light Sections	13.33	2.48	10'-4"	50	34300	
	37		13.30	"	"	"	32700	33400
	76		13.33	"	"	"	33700	
	15		13.40	"	17'-6⅝"	85	34000	
	89		13.43	"	"	"	30000	31600
	90	4-5"x5"x½" @ 11.38 lb. 1-PL 6½"x⅝" @ 1.88 lb. Total = 13.26 lb.	13.29	"	"	"	30700	
	28		13.36	"	24'-9⅝"	120	28300	
	48		13.34	"	"	"	26900	28300
	51		13.33	"	"	"	29000	
7A		Heavy Sections. 4-5"x5"x½" @ 15.30 lb. 1-PL 6½"x⅞" @ 2.83 lb. Total = 18.13 lb.	Not tested					
8	9	Light Sections.	10.98	2.46	10'-3"	50	35900	
	39		11.01	"	"	"	35100	35700
	78		11.03	"	"	"	36200	
	16		11.09	"	17'-3⅛"	85	34400	
	81		11.05	"	"	"	32900	32800
	82	4-6"x3½"x½" @ 9.60 lb. 1-PL 7½"x⅝" @ 1.75 lb. Total = 11.35 lb.	11.11	"	"	"	34000	
	27		11.06	"	24'-7⅝"	120	29100	
	46		11.11	"	"	"	29400	29700
	50		11.16	"	"	"	30400	
8A	100	Heavy Sections.	25.78	2.51	10'-5½"	50	33000	
	126		25.86	"	"	"	33500	32900
	127		25.83	"	"	"	32200	
	156		25.56	"	17'-9⅛"	85	31300	
	160		25.57	"	"	"	25300	29400
	161	4-6"x3½"x½" @ 22.20 lb. 1-PL 7½"x⅜" @ 4.38 lb. Total = 26.58 lb.	25.43	"	"	"	31500	
	162		25.66	"	25'-1⅜"	120	27500	
	163		25.70	"	"	"	27000	27300
	164		25.68	"	"	"	27500	
10	3	Light Sections	10.77	2.33	9'-8½"	50	36100	
	4		10.80	"	"	"	35700	35800
	53		10.86	"	"	"	35600	
	19		10.78	"	16'-6⅜"	85	32500	
	83		10.76	"	"	"	31900	32100
	86	2-PI 9½"x⅝" @ 4.500 lb. 4-L 2½"x2½"x¼" @ 3.750 lb. 2-PI 5½"x¾" @ 2.625 lb. Total = 10.885 lb.	10.76	"	"	"	31900	
	23		10.75	"	23'-3⅜"	120	28400	
	33		10.76	"	"	"	28300	28400
	34		10.75	"	"	"	28400	
10A	104	Heavy Sections.	18.60	2.34	9'-9"	50	31400	
	167		18.52	"	"	"	32000	31800
	170		18.46	"	"	"	32100	
	144		18.67	"	16'-6⅜"	85	28000	
	149		18.65	"	"	"	28000	28300
	157	2-PI 9½"x⅝" @ 7.88 lb. 4-L 2½"x2½"x¼" @ 6.24 lb. 2-PI 5½"x½" @ 4.59 lb. Total = 18.71 lb.	18.69	"	"	"	29000	
	140		18.64	"	23'-4⅜"	120	27000	
	141		18.80	"	"	"	25900	26300
	142		18.65	"	"	"	26000	

CONDENSED TABULATION OF THE COLUMN TESTS MADE BY THE UNITED STATES BUREAU OF STANDARDS IN CO-OPERATION WITH COMMITTEE OF AMERICAN SOCIETY OF CIVIL ENGINEERS

the yield-point as the length is decreased and thereby the eccentricity moment made less important. It is proved more definitely by the unmistakable inferiority of the heavy sections to the corresponding light sections. The difference varies from 1,000 to 8,000 lb. per sq.in. The real condition is obscured by the fact that small test pieces of the heavy sections had a higher yield-point *in tension* than test pieces of the light sections (see table). But later the compressive yield-point was measured, by testing short blocks—columns a little less than 4 ft. long—cut from some of the large columns of types 1 and 1-A and tested in compression. While these blocks gave high ultimate crushing strengths (see table), their yield-points, as shown by curves from extensometer measurements (made on the seventh repetition of loading to 30,000 lb. per sq.in.), were 34,000 to 36,000 lb. per sq.in. for the light sections and 30,500 for the heavy sections. Thus there was a difference of at least 5,000 lb. in yield-point in favor of the light sections, although the tensile yield-point was higher for the heavy section.

Since the difference in compressive yield-point of light and heavy sections coincides well with the difference in strength of the light and heavy sections, it is clear that the yield-point limits the column strength.

⁂

The Cost of Generating Hydro-Electric Power at the Panama Canal hydro-electric station at Gatun is given in the annual report of Capt. W. H. Rose, electrical engineer. The present capacity of the station is about 6,000 kw., and the average monthly power output from the station during the first six months of 1915 was about 2,500,000 kw.-hr. From Jan. 1 to June 30, 1915, the operating cost of the station was 0.09c. per kw.-hr. This cost includes all operation, maintenance and division overhead charges, but does not include a charge of 3% per annum on the investment in the entire power system to cover functional depreciation. If this depreciation charge is included, the cost of power at the hydro-electric station for six months from January to June was 0.44c. per kw.-hr. The total cost of the station was about $650,000; and considering present prices of electrical equipment and the labor situation on the isthmus, it is probable that the station would cost at least this amount if built at the present time. It is noteworthy that the capital cost of this investment does not include anything for the regulating dam or spillway, so that the hydro-electric plant was built under conditions particularly favorable for low cost of construction.

News of the Engineering World

Engineering-Society Members To Aid in Preparedness

A plan has been worked out by a committee of the Naval Consulting Board in coöperation with representatives of the national engineering societies under which the members of the national engineering societies are to so organize the industrial forces of the United States that they may act promptly in case of national necessity. On Jan. 13 President Wilson sent the following letter to the president of the American Institute of Mining Engineers, and similar letters were sent to the American societies of civil, electrical and mechanical engineers and to the American Chemical Society.

The White House, Washington, Jan. 13, 1916.

My Dear Sir:

The work which the American Institute of Mining Engineers has done, through its members on the Naval Consulting Board, is a patriotic service which is deeply appreciated. It has been so valuable that I am tempted to ask that you will request the institute to enlarge its usefulness to the Government still further by nominating, for the approval of the Secretary of the Navy, a representative from its membership for each state in the Union, to act in conjunction with representatives from the American Society of Mechanical Engineers, the American Society of Civil Engineers, the American Institute of Electrical Engineers and the American Chemical Society, for the purpose of assisting the Naval Consulting Board in the work of collecting data for use in organizing the manufacturing resources of the country for the public service in case of emergency.

I am sure that I may count upon your cordial coöperation.

With sincere regards, cordially yours,

(Signed) WOODROW WILSON.

Special meetings of the directors of the societies were held on Friday, Jan. 21. The Council of the American Society of Mechanical Engineers authorized the president and secretary to select the member from each state from a list of five names chosen by the Council. The presidents and secretaries of the five societies are to constitute a joint committee to supervise the organization.

It will be seen that under this plan there will be in every state of the Union a committee of five made up of one member from each of the five societies named. This committee in each state will undertake the task of preparing an inventory of its industrial resources that would be available in case of need. Under direction of a committee of which Mr. William L. Saunders, president of the American Institute of Mining Engineers, is a member, a preliminary canvass has been made in the State of New Jersey, and it is found that there are about 800 different manufacturing plants in that state producing articles which would be of use for the nation's forces in the event of war. These articles include not merely arms and ammunition, but blankets, clothing, shoes, vehicles, food products of many kinds, and in addition the transportation facilities, railways, highways, and waterways available for transporting troops, munitions and supplies in time of war.

It is the intention of course that this proposed census of industrial plants shall be not merely the ordinary census, such as could be collected by a statistical bureau of the Government, but a census, made with the aid of expert knowledge, which will indicate the capacity and efficiency of the different plants to produce certain materials and will include records of the experienced experts in their employ who could be called upon for special service there or elsewhere. In general it will be just such information as some of the European countries now at war have spent many months to obtain since hostilities began and which would have been of enormous advantage to them had it been in their possession at the outset.

Suitable blanks are to be furnished for the committees in each state, on which the information can be collected in systematic fashion. It is the expectation that these committees well serve without compensation, performing the work as a patriotic service to their country. The committee in each state will obtain the aid of the members of the five national societies resident in the state, and doubtless of other engineers as well who can aid in collecting the desired data from local sources.

According to a statement by Secretary Daniels, when the desired information is at hand it is proposed that the Government shall foster the development of industries which may be relied upon for national defense. This purpose is to be achieved, by a wider distribution of Government orders for material, so that many small plants will receive orders instead of concentrating the purchasing from the large plants of the country.

Kansas Engineering Society

The eighth annual meeting of the Kansas Engineering Society was held at the State Agricultural College, Manhattan, Kan., Jan. 18 and 19. This society probably holds the record for low membership dues, which are only $2 a year; yet it publishes a 150-page volume of "Transactions" and has become an active factor for the general well-being of the state.

The society is taking hold of many of the broader problems of the engineering profession and of the state in an earnest desire to make its influence felt for good. The papers and discussions of this meeting covered quite thoroughly such subjects as the manufacturing and industrial status of Kansas, the problems of state-wide flood control, the economic and financial phases of local state-road construction, the county engineer and his difficulties and opportunities, and the licensing of engineers.

The more technical papers included such subjects as "The Effect of Diesel Engines on Fuel Supply," "Instruction in Shop Practice to Engineer Students," "The Drainage of Railway Roadbeds," "Concrete-Road Construction at the Kansas State Agricultural College," "The Value of Public-Service Properties" and "Railway Electrification." A historical paper of more than local interest was that of J. M. Meade, Engineer of the Eastern Lines of the Atchison, Topeka & Santa Fe Ry., on "Early Kaw River Bridges." This gave an excellent résumé of the various attempts to build and maintain a bridge over the Kaw River at Topeka, dating from the

first pile bridge constructed in 1857-58 and carried away by a flood in 1858.

The problem of flood control is looming up very large in Kansas at the present time. It is estimated that the flood damage of the past year alone amounted to about $25,000,000, and in the last 13 yr. to double that amount. Under its present constitution the State of Kansas has no authority to undertake the work of internal improvements, either for flood control and prevention or for better transportation, so that a considerable part of the discussion at the meeting concerned proposed legislation rather than engineering methods.

There seemed to be a general sentiment in favor of licensing engineers, at least so far as to prevent the appointment of incompetent county engineers. A committee of the society recommended the proposed license law drawn by the committee of the four national engineering societies a year ago, but suggested modifications to suit local conditions. The controlling element in the society, however, appeared to take a more conservative view and was against hastening any legislation.

The new officers of the society are: President, Alva J. Smith, Consulting Engineer, of Emporia; Vice-President, H. B. Walker, Engineer of Drainage and Irrigation of Kansas, of Manhattan, Kan.; Secretary-Treasurer, C. A. Foster, City Engineering Department, Topeka, Kan.

Boston Engineers Decapitated

Wholesale decapitation of engineers and other members of the technical staff of the Public Works Department of Boston was announced by James M. Curley, mayor, on Jan. 21. The 17 men affected had been in the service of the city for periods ranging from 41 to 7 yr., but were given only 48 hr. notice of their removal. To avoid civil-service rules the positions were declared abolished, but the mayor announced that all the positions will be filled by men now in the service, "but the positions may not bear the same titles." The names, titles, dates of appointment to position just abolished, salaries and dates of beginning service in the Department of Public Works are as follows:

Frank A. McInnes, M. Am. Soc. C. E., Division Engineer in Charge of Sewer and Water Service since 1911, at $5,000 a year; 1887. George H. Foss, Supervisor of Sanitary Service since 1911, at $3,000 a year; 1888. Frederick I. Winslow, M. Am. Soc. C. E., Engineer of Extension, Water Service since 1911, at $2,700 a year; 1881. Frederick P. Spaulding, Assistant Engineer of Construction, Bridge and Ferry Division since 1887, at $2,100 a year; 1880. Bliss W. Robinson, Superintendent of the Main Drainage Works since 1909, at $2,500 a year; 1909. Storrs L. Durkee, Supervisor of Permits since 1913, at $2,400 a year; 1908. Joseph W. Swan, Deposit Clerk, Water Service since 1875, at $2,000 a year; 1875. Edward C. Wade, Supervisor of Street Lighting since 1911, at $1,800 a year; 1884. Alfred E. Haskell, Assistant Engineer, Paving Service since 1891, at $1,800 a year; 1891. George A. Clough, Assistant Engineer, Bridge and Ferry Division since 1906, at $1,600 a year; 1887. Clarence G. Norris, Assistant Engineer, Sewer Service since 1912, at $1,500 a year; 1896. Albert W. Badger, Assistant Engineer, Sewer Service since 1912, at $1,100 a year; 1905. William J. Watkins, Draftsman, Sewer Service since 1898, at $1,500; 1896. Lloyd H. Chase, Chief Inspector, Paving Service since 1909, at $1,400 a year; 1900. Frank O. Holmes, Instrumentman, Paving Service since 1908, at $1,400; 1895. William F. Sinclair, Transitman, Bridge and Ferry Division since 1896, at $1,200 a year; 1891. Dr. Arthur H. Davison, Examining Physician since 1908, at $1,000 a year; 1889.

On Jan. 24 Mayor Curley filled the 17 positions by transfer or promotion, with a reported saving of $11,000 annually. The more important of these positions were: John M. Shea, Chief Engineer Paving, Sewers and Water-Works, at $3,600 a year; Thomas F. Bowes, Engineer in Charge Sewer Service, $3,500; Joseph T. Norton, in Charge Sanitary and Street Cleaning Services, $3,500; John E. Carty, Engineer Bridge and Ferry Division, $5,000. At the same time salary increases were given to 59 employees in the Public Works Department.

Portland-Cement Production Shows Slight Decrease

The United States Geological Survey's preliminary estimate of the portland-cement production for 1915, made by Ernest F. Burchard, shows that there was a slight decrease in production from that of 1914 but that the shipments were a trifle in excess of the previous year. The shipments from the mills amounted to 86,524,500 bbl., compared with 86,437,956 bbl. in 1914, an increase of 0.1%; the production was about 85,732,000 bbl., compared with 88,230,170 bbl. in 1914, a decrease of 2.8%; and the stocks of finished cement at the mills were about 11,583,000 bbl., compared with 12,893,863 bbl. in 1914, a decrease of 10.2%. The slight decrease in production and the considerable decrease in stock indicate greater caution in the industry, which in the preceding few years showed a tendency toward overproduction.

The itemized figures by districts are given in the accompanying table:

	Shipped		Produced		Stocked	
	Bbl.	% Changes from 1914	Bbl.	% Changes from 1914	Bbl.	% Changes from 1914
Lehigh district	24,500,000	+ 2.2	24,860,000	+ 1.0	3,460,000	+10.9
New York State	5,236,500	— 4.3	5,097,000	—13.4	825,000	—15.1
Ohio and Western Pennsylvania	7,400,000	— 0.9	7,200,000	— 5.2	750,000	—33.8
Michigan and Northeastern Indiana	5,545,000	+ 7.5	5,550,000	+ 6.4	650,000	— 4.3
Southern Indiana and Kentucky	2,780,000	— 5.2	2,840,000	— 3.1	490,000	+12.5
Illinois and Northwestern Indiana	10,825,000	— 4.3	10,200,000	—11.6	1,511,000	—29.2
Iowa and Missouri	9,200,000	+ 3.0	9,250,000	+ 3.3	1,290,000	—12.4
Pacific Coast	5,867,000	—16.8	5,712,000	—19.5	880,000	—11.0
Kansas, Nebraska, Oklahoma and Central Texas	6,546,000	+ 8.8	6,378,000	+ 2.0	786,000	—23.9
Colorado, Utah, Montana and western Texas	2,475,000	—10.2	2,525,000	— 6.4	30,000	+42.5
Maryland, Virginia, and West Virginia	3,150,000	+12.8	3,145,000	+12.9	348,500	+ 4.8
Tennessee, Alabama and Georgia	3,000,000	+16.4	2,975,000	+11.3	292,500	—23.7

The general prices averaged a few cents lower per barrel in 1915 than in 1914, although toward the end of the year they were considerably higher. The statistics show that the general volume of business was about the same as in 1915, though it was not uniformly distributed throughout the year. During the early part of the year the demand for cement was not great, and in some districts the industry was depressed during the summer by excessive rainfall, but in the last four months or more a decided change for the better has occurred both in demand and prices, so that the outlook for 1916 is brighter than for several seasons.

Professor Crandall Retires After Long Service

On Jan. 21 the Cornell Society of Civil Engineers gave a dinner in New York City in honor of Prof. Charles Lee Crandall, of the College of Civil Engineering of Cornell University, who is retiring this year after 41 yr. of continuous service as an instructor of civil engineering. Professor Crandall was born in Bridgewater, N. Y., in 1850 and graduated from Cornell in 1872 with the first class to complete the regular four-year course. He joined the instructing staff of the College of Civil Engineering

CHARLES LEE CRANDALL

in 1874 and since 1895 has held the title of professor of railroad engineering. Following the death of Dean E. A. Fuertes in 1903, he served as head of the college for three years. He is now retiring as professor emeritus.

Professor Crandall's main work has of course been the teaching of geodesy and railroad engineering to a long line of Cornell men, but he has found time not only for authorship—his books on geodesy and railway engineering being pioneers in their line—but also to be city engineer of Ithaca for a number of years. His work on the Committee of Iron and Steel Structures of the American Railway Engineering Association is probably his leading contribution to noneducational activities.

As compiler of the annual list of Cornell civil engineers he has continued that personal relation with his students which so endeared him to all who attended his classes or who followed his steady, rapid pace over the ten-mile hike back home from a day's field practice in railway location.

A testimonial of the high regard and affection in which he is held by the alumni will be presented to the university, to be known as the Charles Lee Crandall Prize Fund, for which the sum of $3,000 has been provided by the graduates of the College of Civil Engineering. The income from the fund will be used to furnish prizes for exceptional work by undergraduates on subjects assigned by Professor Crandall.

United States Supreme Court Upholds Smoke Ordinance

Of more than local interest because of some broad general principles enunciated is the decision of the United States Supreme Court handed down on Jan. 10, 1916, upholding the validity of the smoke ordinance passed by the city of Des Moines, Iowa, on Sept. 6, 1911. (The Northwestern Laundry and T. R. Hazard, appellants, vs. the City of Des Moines, *et al.*; appeal from the District Court of the United States for the Southern District of Iowa.)

The ordinance in question declared the emission of dense smoke in portions of Des Moines a public nuisance and prohibited the same. As is usual in such cases, the contestants of the validity of the ordinance submitted a long list of allegations of unreasonableness, excessive authority and the like. The city moved to dismiss the bill on what was virtually a demurrer. The lower court granted the motion and entered a decree dismissing the bill with prejudice. An appeal was then taken to the United States Supreme Court.

Portions of the decision of the higher court of broad general interest are as follows:

So far as the Federal constitution is concerned, we have no doubt the state may by itself or through authorized municipalities declare the emission of dense smoke in cities or populous neighborhoods a nuisance and subject to restraint as such; and that the harshness of such legislation, or its effect upon business interests, short of a merely arbitrary enactment, is not valid constitutional objection. Nor is there any valid Federal constitutional objection in the fact that the regulation may require the discontinuance of the use of property or subject the occupant to large expense in complying with the terms of the law or ordinance. Recent cases in this court are Reinman vs. Little Rock, 237 U. S. 171; Chicago & Alton Railroad Co. vs. Tranberger, 238 U. S. 67; Hadacheck vs. Sebastian, Chief of Police, decided Dec. 20, 1915.

That such emission of smoke is within the regulatory power of the state has been often affirmed by state courts. Harmon vs. Chicago, 110 Ill. 400; Bowers vs. Indianapolis, 169 Ind. 165; People vs. Lewis, 86 Mich. 273; St. Paul vs. Haugbro, 93 Minn. 59; State vs. Tower, 185 Mo. 79; Rochester vs. Macauley-Fien Milling Co., 199 N. Y. 207. And such appears to be the law in Iowa, McGill vs. Pintsch Compressing Co., 140 Iowa, 429.

Discussing the allegation that the Des Moines ordinance was in excess of the legislative grant, the Supreme Court pointed out the reasonableness of the ordinance in providing that the smoke inspector "must be qualified by training and experience to understand the theory and practice of smoke inspection" and that in addition he "has the benefit of counsel of the smoke abatement commission, consisting of five members . . . at least one of whom must have had experience in the installation and conduct of power and heating plants."

The assertion of "arbitrary classification" the Supreme Court declared had been "so often discussed that nothing further need be said" upon this point. The court did, however, go on to say that the Des Moines ordinance "applies equally to all coming within its terms, and the fact that other businesses might have been included does not make such arbitrary classification as annuls the legislation. The classification is not illegal "because certain cities are included and others omitted in the statute."

National Drainage Congress

The sixth annual meeting of the National Drainage Congress was held at Cairo, Ill., Jan. 19 to 21. The meeting dealt mainly with questions of rivers and flood control. Of fifteen papers ten related to this subject, including legislation, two to river navigation and only three to drainage proper.

The presiding officer was Frank B. Knight, consulting engineer, of Chicago. Opening addresses were made by James M. Graham, Springfield, Ill., representing Governor Dunne, and by Walter H. Wood, mayor of Cairo. Mr. Wood held up Cairo as an example of the necessity and importance of river regulation and flood control, the city being within a drainage district and its very existence being dependent upon the levees that protect it from the flood waters of the Ohio and the Mississippi on either side.

The attendance was not as large as had been expected, the total registration being about 170. The entertainment included a reception, an automobile trip to see the operation of the flood gates of the Cairo drainage district, and a steamboat trip on the rivers.

The relation of drainage to agriculture was outlined in a paper on "Farm Drainage," by John T. Stewart, agricultural engineer for the University of Minnesota. He dealt particularly with tile drains and their effect upon the general improvement of the soil. A special problem in ditch drainage is the maintenance of ditches consequent upon their deterioration due to caving and silting. This was discussed by A. M. O'Brien, chief engineer of the Little River Drainage District (Missouri). The organization of drainage districts always involves expenses for preliminary surveys and legal work, and methods of providing funds for such expenses were explained by R. B. Oliver, Jr., attorney for the drainage district just mentioned. These three papers were all that dealt with drainage proper.

Federal legislation in the interest of stream control was discussed by F. H. Newell, University of Illinois, formerly chief engineer of the United States Reclamation Service. He compared the present situation to that which preceded the passage of the reclamation act providing for the improvement of the arid lands by irrigation. The Government now is amply equipped for dealing with the drainage and stream-control problem through the combined forces of the Reclamation Service and the Department of Agriculture. He predicted that in the near future some opportune step or movement would cause Congress to authorize action in this direction in the same way that it authorized action in regard to irrigation. State legislation, as represented by the Ohio conservancy act, was discussed by E. H. Bohm, Cleveland, Ohio.

The suggestion was made by L. K. Sherman, engineer member of the Illinois Rivers and Lakes Commission, that every state should have an organization similar to this commission, to represent it effectively in dealing with the Federal Government, particularly the War Department, in matters relating to river improvement or regulation within the state.

A group of six papers dealt with river and flood control in the Pittsburgh district, the Miami and Mississippi Valleys, Indiana and California. In regard to the Mississippi River control and improvement, a most interesting display of moving pictures was given by J. K. Melton, Illinois Central R.R. One set of films showed views of varying bank conditions at intervals along the course of the river from Cairo to New Orleans. Other films of direct engineering interest represented the various methods of building levees—from wheelbarrows and wheeled scrapers to excavating and earth-handling machines—and of protecting the banks by brush mattresses, stone riprap and concrete paving.

The improvement of the Missouri River between Kansas City and St. Louis was described by Clark E. Jacoby, consulting engineer, Kansas City. Prof. J. L. Van Ornum, Washington University, St. Louis, discussed the relation of land drainage to the improvement of rivers for navigation. In an address by Paul W. Brown, of the St. Louis *Republic*, it was suggested that while the assistance of the Federal Government is both desirable and necessary, the question of river control is one for coöperation. The cities must do their part in providing water terminals (as in the case of the St. Louis project described recently in *Engineering News*, Jan. 13, 1916), and the various states and organizations must do their part, while the Federal Government is asked only to do its proper share and not to undertake the entire work as a national enterprise.

A resolution was adopted urging the action of Congress upon the related problems of river and flood control and land drainage, and indorsing the present Clark and Newlands-Broussard bills.

Officers for 1916 were elected as follows: President, George Parsons, Cairo, Ill.; Vice-Presidents, Frank B. Knight, consulting engineer, Chicago; D. E. King, Missouri Pacific System, St. Louis; Gen. Wm. C. Gorgas, U. S. A.; J. L. Craig, California River Regulation Commission, Stockton, Calif.; and Geo. M. Lehman, Chief Engineer of the Lake Erie & Ohio River Canal Board, Pittsburgh, Penn.; Secretary, Philip R. Kellar, Chicago. The selection of the place for the next meeting was left in the hands of the Executive Committee.

Sheet-Copper Aqueduct Lining

The precautions being taken to insure the integrity of the Catskill Aqueduct are illustrated by the following statement regarding the proposed copper lining of two short 12-ft. sections, aggregating some 1,200 ft., of the city tunnel near 24th St., bids for which are to be received on Feb. 1, 1916. The statement, which was prepared for *Engineering News* by Alfred D. Flinn, Deputy Chief Engineer, Board of Water-Supply, City of New York, is as follows:

The city tunnel throughout its entire length has been subjected to test under hydrostatic pressure equal to that of working conditions, as have all the other portions of the Catskill Aqueduct. Under this test in the portion of the tunnel between shafts 18 and 19 a number of small cracks developed within two stretches, one approximately 1,000 ft. long and the other approximately 900 ft. long. (Total length of the city tunnel is 93,903 ft.) These cracks were so small and the loss of water through them so trifling that if the defects had occurred outside the city very little attention would have been paid to them. In these portions the rock around the tunnel seems to compress slightly when the tunnel is under pressure, and in order to prevent the leakage when the tunnel is in service and the cracks are opened by the pressure, a water-tight, slightly flexible metal lining is to be installed in such short stretches as may be found necessary. For this purpose sheet copper, about 5/64 in. thick, has been adopted. The plates are to be corrugated longitudinally at a few places in the periphery of the tunnel to provide for the slight movement when pressure is put on. The plates making up the tube will be brazed together at their seams.